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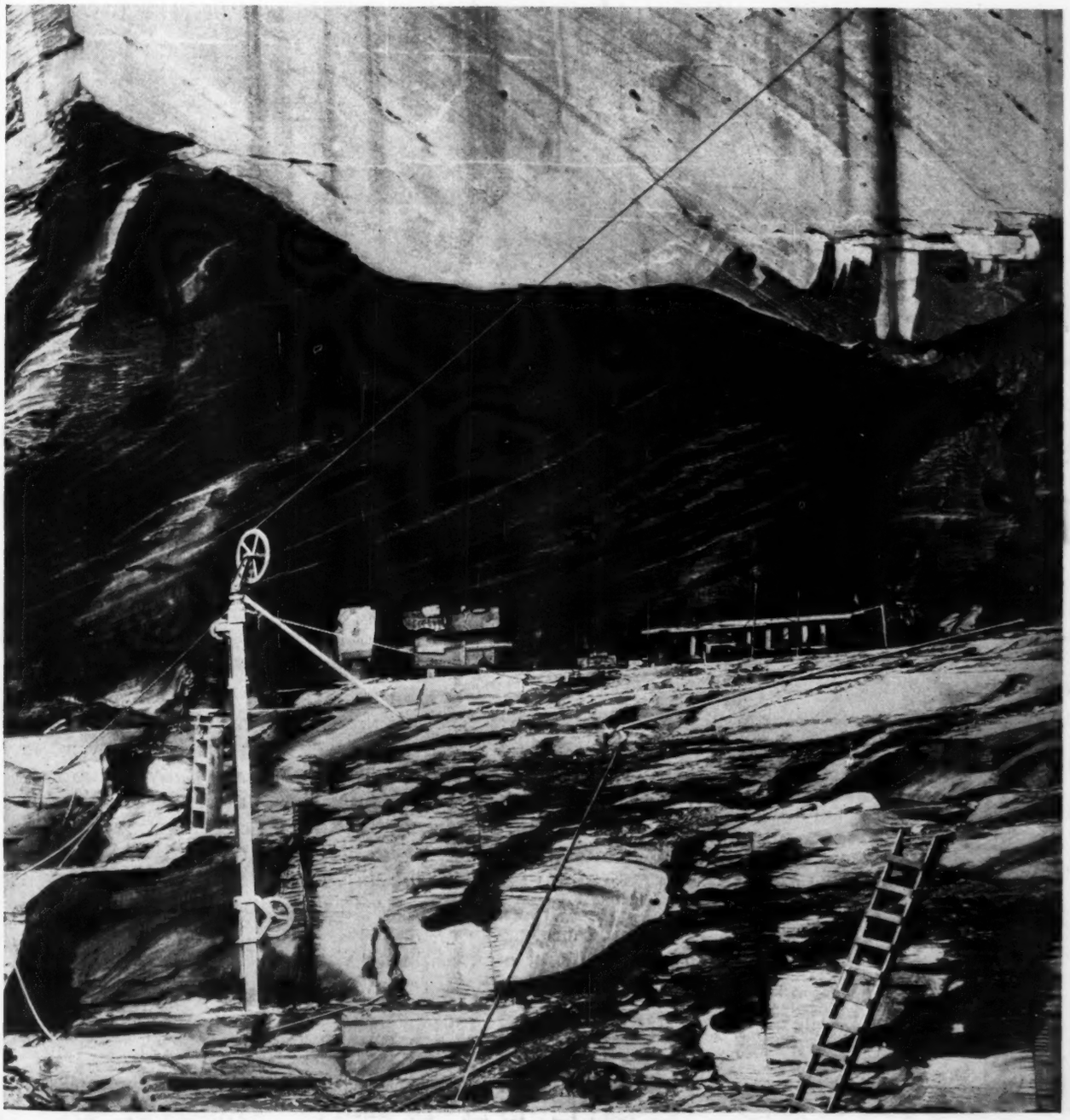

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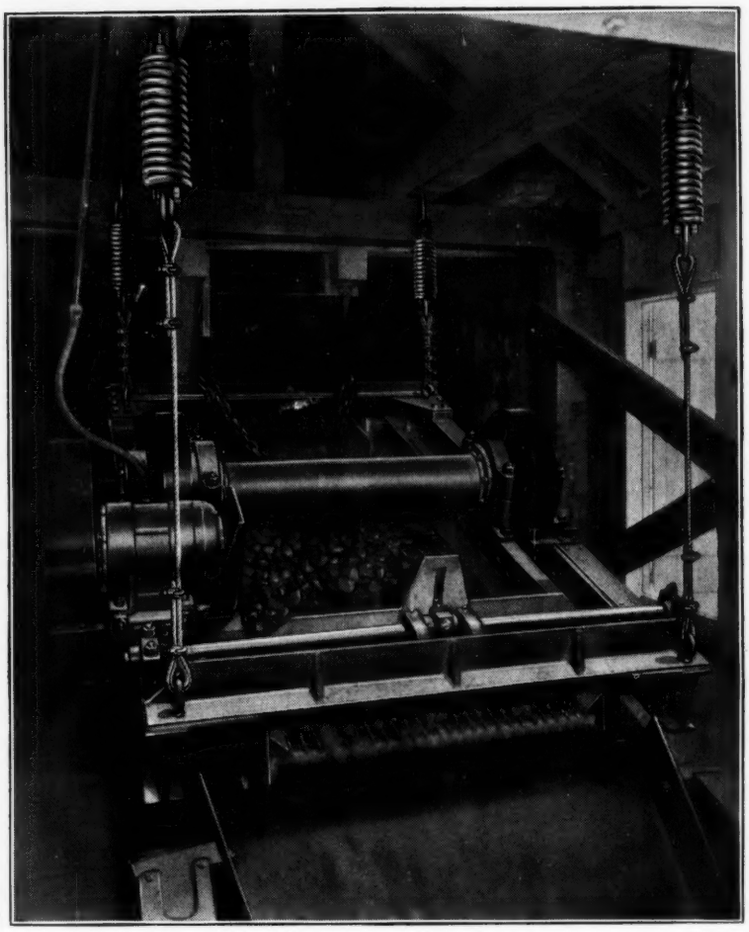
April 27, 1931



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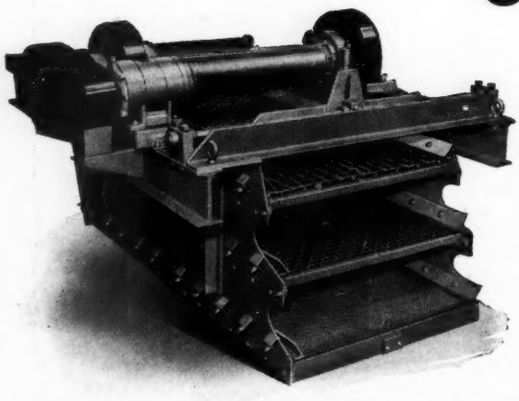

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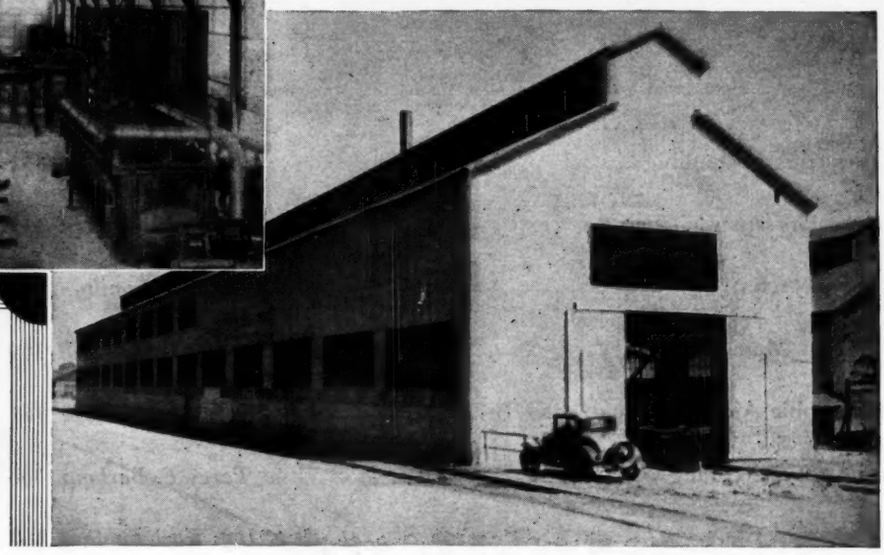
Announcing

Interior and exterior views of the new grinding ball unit at the Pueblo steel works of The Colorado Fuel & Iron Company



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Engineering and Mining Journal

April 27, 1931 A. W. ALLEN, *Editor* Vol. 131—No. 8

Quicksilver Metallurgy

Losses and Recoveries

QUICKSILVER has received little technical attention, because it is a metal of secondary importance and because a relatively simple metallurgical method produces commercial results. Metallurgical balance sheets rarely have been attempted; and, although efforts were made to determine furnace losses, the information resulting is scanty. Dr. L. H. Duschak and Mr. C. N. Schuette have stressed the need for accurate sampling and the value of metallurgical balances, and Mr. H. W. Gould has provided information of value, but probably the best data on the quicksilver balance sheet are those given by Mr. Worthen Bradley in a recent United States Bureau of Mines Information Circular describing plant and practice at Sulphur Bank, Calif. A ratio of concentration of 5:2 is secured by screening, sorting, and tabling, 80 per cent of the quicksilver being recovered in the concentrate, which forms the furnace feed. In furnacing, about 85 per cent of the quicksilver is recovered and 15 per cent is lost: in furnace residues, 4.6 per cent; stack, 3 per cent; miscellaneous, 2 per cent; and unaccounted for, 5.4 per cent. The total recovery, based upon the mined product, is 68 per cent.

These results are of interest. Although applying to a difficult ore, they probably indicate maximum losses that may be expected with dusty furnace ores. With more favorable ores a higher recovery may be expected. Duschak and Schuette state in connection with the Scott furnace that no difficulty should be experienced in delivering to the condenser 95 to 100 per cent of the quicksilver in the furnace feed. In discussing rotary-furnace practice at New Idria, an almost complete extraction of the quicksilver is claimed.

The Scott furnace produced a gas stream almost free from dust. The principal objections to its use were the effects of expansion and contraction. When used for ores that released much dust, the rotary furnace had to be supplemented by settling chambers and other expedients. The condensed mercury was contaminated with dust, and the product required special treatment before clean metal could be obtained.

Cottrell treaters were tried to reduce the dust content of the gas stream. Cyclones of various types were next introduced, and more dust was separated. Efficient cyclones were devised, and by the use of groups of such cyclones the gas stream was efficiently cleaned to a desirable extent. Recent plant installations by Mr. Schuette embody these features.

Another development was evolved at the plant of the Sulphur Bank Syndicate in California, under the management of Mr. Worthen Bradley. Experiments were conducted with cyclones, Cottrell treaters, and dust chambers, but the resulting condenser product contained so much dust that retorting of the product was necessary. The condenser mud was then treated in small flotation cells for separation of the mercury, the pulp being recirculated until it was reduced to a final tailing of about two pounds quicksilver per ton. The flotation product was dewatered, dried, and retorted. By flotation, a condenser product containing somewhat less than four per cent quicksilver was raised to about thirty per cent, and the dust largely eliminated. This development points to the use of the rotary furnace, the acceptance of a condenser product containing only the portion of dust that cannot be easily separated mechanically, and the cleaning of this product in flotation cells. It also points to the use of scrubbers for receiving the gas stream, and for performing the function of condensing and removal of both dust and quicksilver from the gas stream, as suggested by Mr. P. R. Bradley. The ability economically to clean a low-grade condenser mud foreshadows a simplification of furnacing and condenser installations and an advance in the treatment of low-grade quicksilver ores.

Working the Less Attractive Gold Deposits

NARROW WORKINGS were a usual feature of old-time mining. A width of stope or drift was ample if it sufficed to admit a single-jacker with his steel. Even now, the chance encountering of some isolated working place that, according to modern notions, is too small occasions no surprise. But use of such relatively inefficient methods became infrequent with the introduction of machine drills, and the growing scarcity of high-grade ore deposits, to say nothing of the increase in the workingman's consciousness of his rights. Therefore, the commercial exploitation, on a large scale and at a profit, of extremely narrow veins on the Rand still attracts attention, though the venture has long since passed the experimental stage.

At the suggestion of the late Mr. W. A. Quince, former manager of the Sub Nigel gold mine, an investigation was made with a view to improving the method of handling the broken rock in narrow stopes. The story is told by Mr. S. N. Hoffenburg in the November issue of the *Journal* of the Chemical, Metallurgical and Mining Society of South Africa. On the 123 stope faces in the mine, the average stoping width for the four months ended Jan. 31, 1930, was 23 inches, the average dip of the reef being 13½ degrees. By devising a special scraper (a hand tool) for use in place of a shovel, a tray on skids for moving the broken ore down the dip to the nearest track, and a special car only 26 in. high for transferring it to the slope track for hoisting, the output

per native worker-shift was raised from 1.3 tons, attained by shoveling, to 3.75 tons, in six stopes where the investigation was conducted, the Kafirs also disposing of the waste.

This work at the Sub Nigel exemplifies what can be done to increase the output of a desired metal—gold—when ore resources are shrinking, provided a profit is in sight. No doubt, in many places, it would be hard, if not impossible, to find men who would work, as do these African blacks, under the conditions indicated. But necessity is the mother of invention; likewise a spur to grueling effort when times are hard. Perhaps more of the abandoned but once productive gold properties throughout the world will be given a new lease of life by special endeavor stimulated by changed economic conditions.

Production and Utilization of Insulating Materials

ACOMMENDABLE co-operative project between government and industry is forecast in the appointment by the United States Department of Commerce of a subcommittee to prepare a booklet that will acquaint builders, as well as present and prospective home owners, with the advantages and economies afforded by properly insulated construction. Methods for avoiding the discomforts of excessive summer heat and severe winter cold are to be presented, and also an impartial discussion of the various types of insulating materials available. Wide distribution of this information is warranted, for the insulation of buildings has not received the attention that it merits, particularly when the added feature of fire-hazard reduction is borne in mind.

For the mining industry, this effort to increase the application of insulating materials in building construction has a twofold significance: first, as a source of the principal raw materials, such as gypsum, asbestos, and diatomite; and, second, as a consumer of the finished manufactured product. This second interest that mining has in these materials is frequently overlooked, even by those members of the industry who have supervision of building construction at camps where the employment of such materials would be particularly successful. An outstanding exception to this observation, however, was described in a series of three articles that appeared early in 1929, in which the authors, Messrs. Harrison E. Clement and James Govan, presented a detailed account of the constructional features of insulated miners' cottages, dormitories, and staff houses that were erected in northern Ontario. The insulating material used was a special calcined gypsum product, shipped to the site in powdered form. Mixed with water, the powder evolves a gas that causes the mass to swell; in this form the material is poured. On hardening, a cellular, pumice-like solid results that is an excellent insulator. Used as a filling for walls, roofs, and floors, this wet-poured gypsum product made the structures fire-safe, insulated, and partly soundproof, besides keeping vermin and rodents out of the walls. Moreover, as the filling is entirely mineral, it does not disintegrate with age. At the conclusion of their series of articles, the authors expressed the opinion that in the future more attention will be paid to the insulation and fire-safeing of wooden buildings, which will continue to be erected to meet climatic and other conditions in isolated camps, particularly where construction budgets are limited or where the enterprise has an indeterminate or short life.

Another interesting phase of the situation, so far as structures already erected are concerned, has been provided by recent tests made by the United States Bureau of Standards on the transfer of heat through building walls. These experiments have shown, according to a report of the bureau, that walls with low insulating values can, by the addition of a half-inch of good insulating material, be endowed with a thermal resistance approximately as great as that of walls of high insulating value.

Apparently, therefore, little excuse can be offered by anyone not using insulated construction. If the aforesaid booklet is accorded the reception and study it should warrant, those erecting new homes will insist on the use of such construction. Mining, of all the industries, should set the pace in the use of insulation materials, not only for the good reasons that have been cited but also because it would obviously be good business to do so.

Amalgamation and the Current Economic Situation

MANY large-scale metallurgical operations in the gold-mining industry in recent years have focused attention on fine grinding and cyanidation. As a result, opportunities have been overlooked for the profitable application of amalgamation for the treatment of small daily tonnages. Operations in some instances have been suspended because a complicated process proved to be economically unsuccessful; other properties are idle because the owners are not aware that an inexpensive method of recovery can be employed. All such properties are worthy of reconsideration today, to determine if a simple process involving low capital expenditure can be applied with profit.

Unfortunately, little progress has been made in improving the technique of amalgamation in recent years. Initiative has apparently been lacking, because the method is considered out of date. The advantage remains to be stressed that it can be employed in conjunction with simple concentration. In such instances, a rich middling may be segregated; but the loss of gold resulting, in the treatment of ores crushed to a degree that avoids all-sliming, is only temporary. Subsequently, when opportunity offers, wet methods may be developed for the recovery of gold from such middling sands. Amalgamation, be it noted, yields gold of native purity, uncontaminated at any stage with base metals, which contamination is a concomitant to hydrometallurgical processes.

Expansion of gold-mining operations is highly desirable, to counteract unemployment and to meet international gold requirements. Moreover, the gold miner now operates under the most favorable economic conditions—low commodity prices, with unlimited demand for his product at a fixed price. Amalgamation offers an easy method of metallurgical recovery at an extremely low capital and operating cost.

Compressed-Air Sampling

Equipment of a new type, reliable and simple in operation, contributes largely to the solution of an unusual ore-testing problem and to the achievement of outstanding metallurgical results at a Tri-State zinc-lead milling plant

Elmer Isern

FROM its inception, the success of the Bird Dog central milling project of the Commerce Mining & Royalty Company, in the Kansas-Oklahoma section of the Tri-State zinc-lead district, was known to be largely dependent on accurate sampling of the ores to be treated. Consequently, much thought was given to this phase of the project. A unique sampling arrangement, operated by compressed air, was finally devised. It has been eminently satisfactory, particularly in accuracy of performance and economy of operation.

As explained in a recent article in this publication,[1] ore is obtained from three separate tracts or allotments, known as the Meh-hunk-kah-zhe-kah, Little Greenback, and Wesa Greenback allotments. These tracts are operated under leases granted through the local Indian agency by the federal government, which acts as guardian for the restricted Indian owners of the land. Royalties accruing to the Indian owners are based on the sales of concentrate produced from the ore mined on their respective lands. The necessity for accurate determination of the valuable mineral content of the ore mined from each allotment is therefore apparent.

Ore mined on the three allotments is hoisted through seven shafts and stored in field hoppers, whence it is transported over a surface haulage system to the mill, as shown in Fig. 1. At the mill office building the ore trains pass over a Howe track scales, equipped with a Streeter-Amet attachment that automatically records the weight of the ore on a tape. A clerk in the office notes on the tape the source of the ore—that is, the allotment on which the ore was mined. The train then passes over four 200-ton subsurface hoppers, as shown in Fig. 2, a separate hopper of the four being assigned to receive exclusively the ore from only one of the allotments. By means of a tripping device, actuated from the office, the ore is automatically dumped from the cars into the particular subsurface hopper designated to receive it.

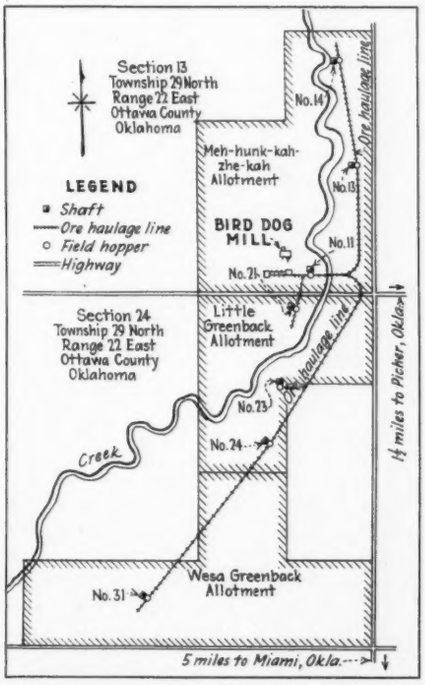


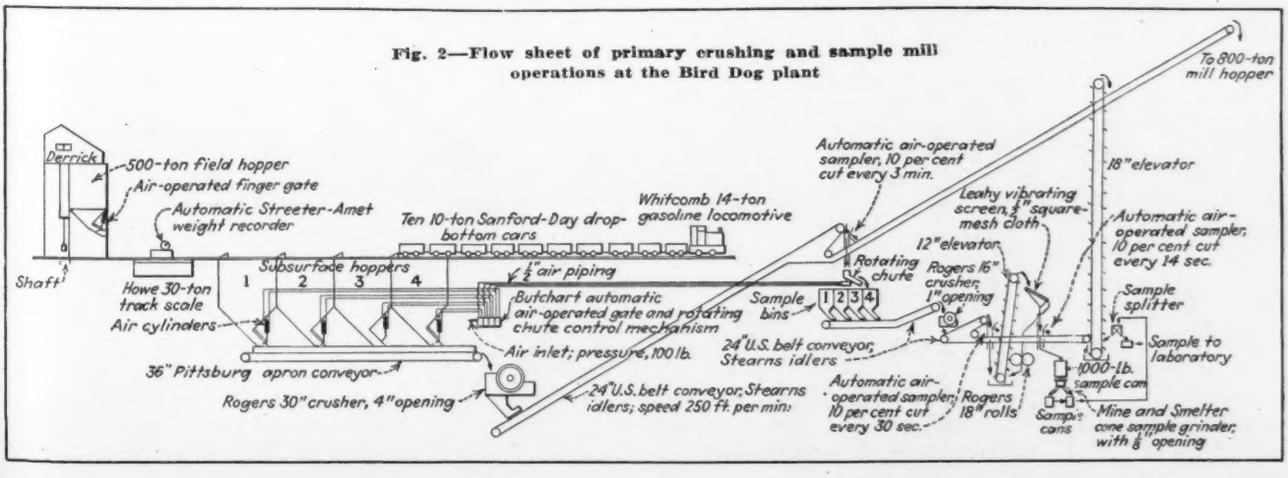
Fig. 1—Sketch map showing the three allotments and central milling plant

Briefly, the sampling problem at the head of the plant comprised: (1) drawing of ore from each of the four subsurface hoppers separately; (2) feeding the ore to a primary crusher; (3) transporting the ore over one conveyor belt; (4) securing accurate samples while the ore was in transit on the belt; (5) depositing these samples into four separate and complementary bins at the sample mill, alongside the main mill. After careful study, the problem was presented to W. A. Butchart. A decision was made, following much designing, to limit the non-automatic operations to the opening and closing of the subsurface hopper gates and feeding the ore to the primary crusher. These operations were to be performed by a single employee stationed at the crusher. All other operations involved were to be entirely automatic.

As finally constructed by the Butchart

[1] "Central Milling in the Tri-State District," by Elmer Isern; *Engineering and Mining Journal*, Vol. 131, No. 2, Jan. 26, 1931, pp. 49-54.

Fig. 2—Flow sheet of primary crushing and sample mill operations at the Bird Dog plant


To 800-ton mill hopper
Derrick
500-ton field hopper
Air-operated finger gate
Automatic Streeter-Amet weight recorder
Ten 10-ton Sanford-Day drop-bottom cars
Whitcomb 14-ton gasoline locomotive
Automatic air-operated sampler, 10 per cent cut every 3 min.
18" elevator
Leahy vibrating screen, ½" square-mesh cloth
Automatic air-operated sampler, 10 per cent cut every 14 sec.
12" elevator
Rotating chute
Rogers 16" crusher, 1" opening
Shaft
Subsurface hoppers
1 2 3 4
½" air piping
Howe 30-ton track scale
Air cylinders
Butchart automatic air-operated gate and rotating chute control mechanism
Sample bins
1 2 3 4
Sample splitter
Sample to laboratory
Air inlet; pressure, 100 lb.
24" U.S. belt conveyor; Stearns idlers
1000-lb. sample car
36" Pittsburg apron conveyor
Rogers 30" crusher, 4" opening
24" U.S. belt conveyor; Stearns idlers; speed 250 ft. per min.
Automatic air-operated sampler; 10 per cent cut every 30 sec.
Rogers 18" rolls
Sample cans
Mine and Smelter cone sample grinder, with ⅛" opening

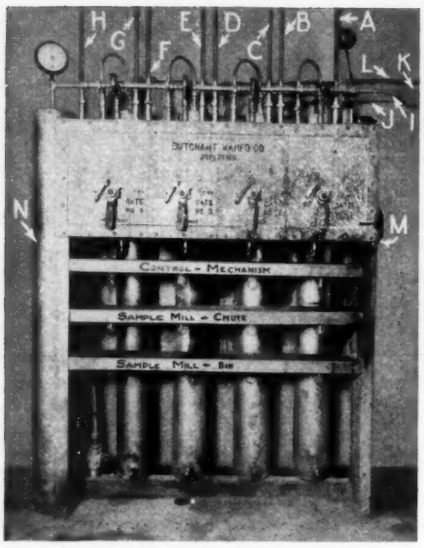


Fig. 3—Controller unit in the subsurface crusher room

A, air line to bottom of No. 1 gate cylinder. *B*, air line to top of No. 1 gate cylinder. *C*, air line to bottom of No. 2 gate cylinder. *D*, air line to top of No. 2 gate cylinder. *E*, air line to bottom of No. 3 gate cylinder. *F*, air line to top of No. 3 gate cylinder. *G*, air line to bottom of No. 4 gate cylinder. *H*, air line to top of No. 4 gate cylinder. *I*, air line to chute cylinder No. 1. *J*, air line to chute cylinder No. 2. *K*, air line to chute cylinder No. 3. *L*, air line to chute cylinder No. 4. *M*, selector or locking wheel. *N*, air receiver.

Manufacturing Company, of Joplin, Mo., and now in constant use for about a year, the sampling arrangement at the head of the plant consists of the following three principal parts, all of which are operated by compressed air at a pressure of 100 lb. per square inch and interconnected, as shown in Fig. 2:

1. A controller unit installed below the subsurface hoppers and near the crusher operator. (See Fig. 3.)

2. An automatic head sampler along the conveyor that cuts, at fixed intervals, a predetermined quantity of ore from the stream on the belt. (See Figs. 4 and 5.)

3. A rotating chute that automatically directs the sample to that particular one of the four sample bins that corresponds in number with the subsurface hopper whence the ore represented by the sample was drawn. (See Fig. 6.)

The mechanism of the controller unit, as shown in Fig. 3, is housed in a four-compartment case, 60 in. long and 16 in. high, built of 6-in. channels and steel plate, with a cast-iron, sectional front that serves as a control panel. The case is dustproof and practically airtight. On the panel are four brass levers, 6-in. long, that hang vertically when not in use, but which can be moved counter-clockwise through an arc of 90 deg. to the operating position. They are retained in this position by a small gravity catch. At one end of the case is a selector or locking wheel. Movement of any lever on the control panel to the operating position performs the following functions:

1. Opens the gate of the subsurface hopper that has the same number as the lever.

2. Locks the controller mechanism, so that none of the other subsurface hopper gates can be opened.

3. Sets a time lock that introduces a time interval between the closing of the gate and the opening of another, during which interval the entire load on the conveyor is discharged.

4. Turns on a signal light above the corresponding subsurface hopper and one of four "control-mechanism" lights at the control panel.

5. Moves and locks the rotating chute above the sample bins, so that it will discharge into a bin that corresponds in number with the subsurface hopper whose gate has been opened.

By means of a commutator on the shaft of the rotating chute above the sample bins, the chute turns on a single light in the middle row of lights below the control panel, indicating the number of bin into which the chute is discharging. The selector or locking wheel is attached to a horizontal shaft extending into the case. On the rim of the wheel are cast the numbers 1, 2, 3, and 4, at intervals of 90 deg., only one number being visible when the wheel is in an operating position. The setting of this wheel indicates from which subsurface hopper ore is to be drawn and, until the setting is changed, confines all subsequent operations of the entire sampling arrangement to that hopper and the corresponding sample bin and signal lights.

To illustrate the operation of the sampling arrangement, assume, for example, that ore is to be drawn from subsurface hopper No. 3. The employee stationed at the crusher starts, first, the main conveyor, which automatically puts the head sampler in operation; next, the crusher, together with the apron feeder. Then he turns the selector or locking wheel of the controller unit until the numeral "3" appears in the operating position. When the wheel is in this position, but not before, he can lift the No. 3 gate lever to the "open" position, in which it is retained by a gravity catch. The position of the selector wheel makes the movement of any of the other levers impossible, and the movement of No. 3 gate lever to the "open" position sets the time lock, locking the selector wheel in its position. Movement of No. 3 gate lever is also attended by the following results, all which take place within a period of fifteen seconds:

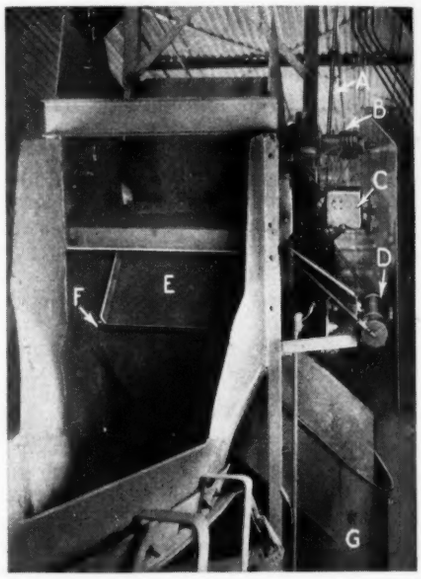


Fig. 5—Head sampler along main conveyor

A, air supply line. *B*, tripper supply shaft. *C*, control mechanism. *D*, actuating cylinder. *E*, gate cutter. *F*, gate cutter pivot shaft. *G*, spout to rotating chute above sample bins.

1. Compressed air in the system passes to the double-acting cylinders that operate the gates of the subsurface hoppers. Air entering the top of the cylinders at gates Nos. 1, 2, and 4 forces these gates shut, but that entering the bottom of the cylinder at gate No. 3 raises it.

2. A light is turned on above hopper No. 3, indicating that the gate of the hopper is open. No. 3 "controller-mechanism" light, below the panel, is also turned on, indicating that ore is being drawn from No. 3 hopper.

3. Compressed air passes to No. 3 cylinder at the rotating chute, which swings the chute to discharge into No. 3 sample bin and locks it in that position. When the rotating chute is

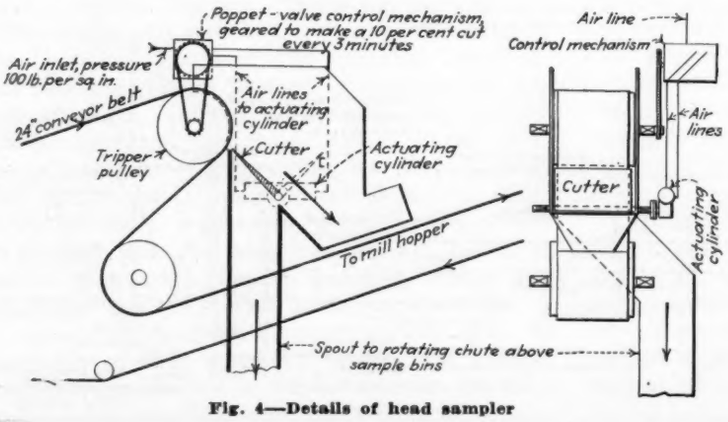

Poppet - valve control mechanism, geared to make a 10 per cent cut every 3 minutes
Air line
Control mechanism
Air inlet, pressure 100 lb. per sq. in.
24" conveyor belt
Air lines to actuating cylinder
Cutter
Actuating cylinder
Tripper pulley
Air lines
Cutter
Actuating cylinder
To mill hopper
Spout to rotating chute above sample bins

Fig. 4—Details of head sampler

in position, No. 3 "sample mill-chute" light below the panel is automatically turned on.

When sufficient ore has been drawn from No. 3 subsurface hopper, No. 3 gate lever is moved by the crusher operator to the original vertical position, almost instantly closing the gate of hopper No. 3. The operator must then wait several minutes for the release of the time lock. This interval permits the load on the conveyor belt to be discharged and the head sampler to complete the sampling of the ore. When the time lock is released, the rotating chute returns to its original position over No. 1 bin, used as a neutral point, and turns on No. 1 "control-mechanism" light, indicating that it has so moved. The selector wheel may then be reset and operations resumed, ore being drawn from any of the other hoppers or the same hopper.

Despite the numerous functions it performs, the mechanism of the controller unit is extremely simple. It consists primarily of four air valves, each of which has a two-way discharge. One discharge is connected with a cylinder at one of the subsurface hopper gates and the other with one of the rotating-chute cylinders. Locking of the mechanism and the manipulation of the lights below the panel is performed by a small air cylinder inside the controller case. The various parts of the unit are in movement only when it is being set. No lubrication is required.

The head sampler, as shown in Figs. 4 and 5, is operated by a tripper-pulley. In passing over this pulley the ore stream on the conveyor leaves the belt, falling onto it again at a lower elevation. A steel gate cutter is periodically moved through the path of the falling ore, the cutter diverting the stream to a spout that leads to the rotating chute above the sample bins. The poppet-valve control mechanism is driven by the conveyor pulley through sprockets and a chain. This arrangement insures continuous operation of the sampler so long as the conveyor is in motion. Adjustable features of the mechanism permit the period of sample cutting to be such that the sample obtained will be any desired percentage of the entire ore stream; for instance, at normal conveyor speed, a sample cutting period of eighteen seconds, every three minutes, yields a 10 per cent sample. The gate cutter is swung by an actuating cylinder, containing two opposing pistons attached to a common spindle. A compressed-air line from the control mechanism leads to either end of the actuating cylinder, and a gear rack cut on the spindle meshes with a quadrant section of a gear fastened to the pivot shaft of the gate cutter.

Construction of the rotating chute, shown in Fig. 6, consists primarily of a steel-plate body held in a frame of 6-in. channels, which is carried on a steel casting attached to the top of a vertical shaft. The chute is inclined at an angle of 45 deg., and, in this position, can be rotated to discharge into any one of the four sample bins. The shaft, with ball bearings, is supported on a welded structural-steel framework. To the lower end of the shaft is keyed a pinion that engages a rack, sliding in guides. Movement can be imparted to the rack by any one of four air cylinders that are contained in a steel housing on the framework and connected with the four compartments of the controller unit by four air lines. Admission of compressed air into any one of the four cylinders will move the rack a certain definite distance, so that the chute is rotated to discharge into a particular one of the four sample bins. When a discharge position above one of the bins is reached, a commutator on the vertical shaft closes an electric circuit that turns on the corresponding "sample mill-chute" light at the controller unit.

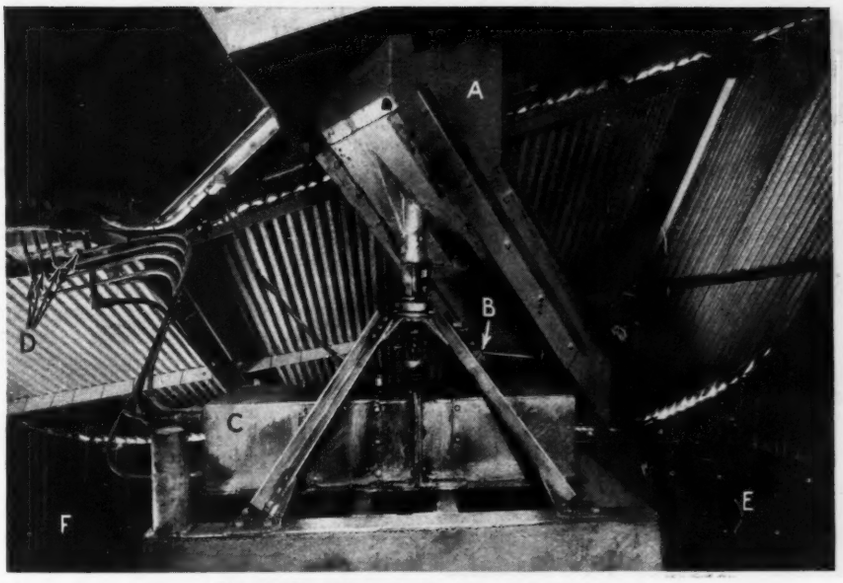


Fig. 6—Rotating chute above sample bins
A, rotating chute. *B*, commutator. *C*, housing containing air cylinders. *D*, air lines from controller unit. *E*, bin No. 3. *F*, bin No. 4.

In the sampling mill, the ore is drawn from the sample bins by hand. When any one of the four sample bin gates is opened, however, the corresponding "sample mill-bin" light, below the control panel, is automatically turned on. Each of the four bins has a capacity of 50 tons and will therefore accommodate the 10 per cent sample cut from 500 tons of ore. This tonnage represents about the daily production from each of the three aforesaid allotments. The fourth subsurface hopper

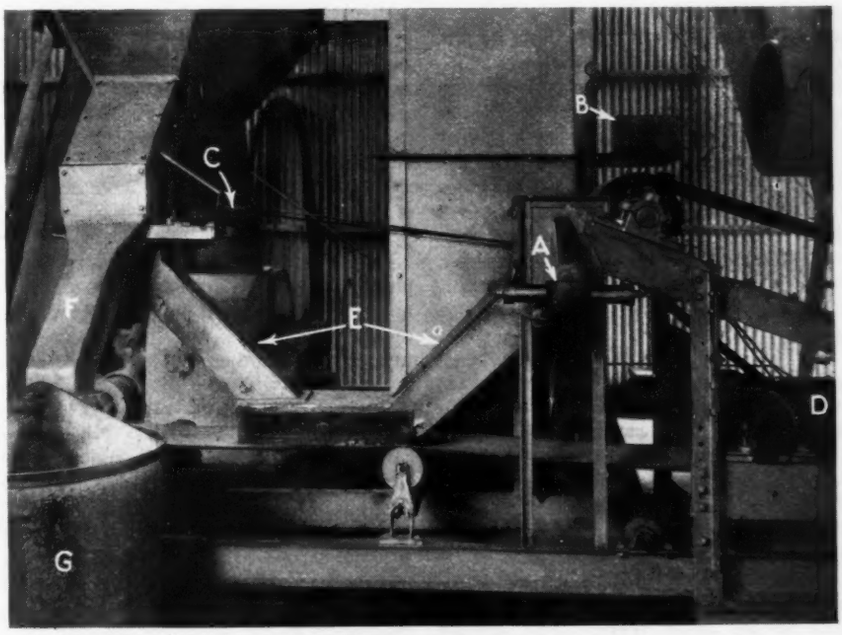


Fig. 7—Samplers in sample mill
A, actuating cylinder of sampler No. 1. *B*, control mechanism of sampler No. 1. *C*, actuating cylinder of sampler No. 2. *D*, control mechanism of sampler No. 2. *E*, reject launders. *F*, launder discharging sample into 1,000-lb. sample can "G."

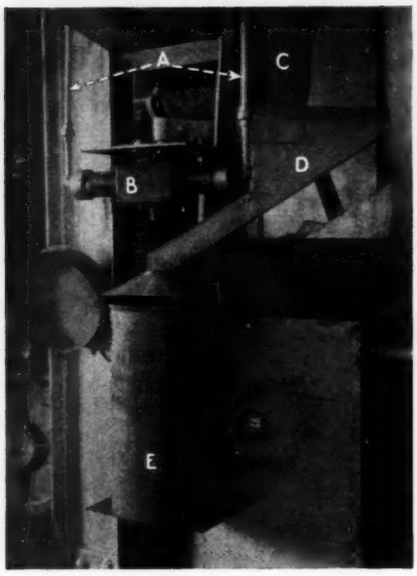


Fig. 8—Sampler in main mill
A, air lines from master control mechanism. *B*, actuating cylinder. *C*, launder. *D*, sample cutter. *E*, sample container.

and sample bin provide a reserve for more extensive operations, including the possibility of milling ore from a fourth allotment.

As indicated in Fig. 2, ore drawn in the sample mill from any one of the four sample bins travels on a 24-in. U. S. conveyor to a 16-in. Rogers crusher, with a 1-in. opening. The product of the crusher is carried by a 12-in. U. S. conveyor over a tripper-pulley, where a gate-cutter sampler, No. 1, similar to the head sampler on the main conveyor but smaller in size, takes a 10 per cent cut of the entire stream every 30 seconds. (See Fig. 7.) This sample is discharged by an 18-in. bucket elevator onto a ½-in. square-mesh Leahy vibrating screen, the oversize of which comprises the feed for a set of 18-in. Rogers rolls that operate in closed circuit with the screens. Undersize from the screen passes through another gate-cutter sampler, No. 2, as shown in Fig. 7, which takes a 10 per cent cut of the stream every 14 seconds. Material rejected by the two samplers falls onto the 12-in. conveyor, which discharges into an 18-in. bucket elevator. From the elevator the rejected material passes to the main conveyor, rejoining the ore stream for discharge into the mill hopper.

At the second sampler the sample is directed into a 1,000-lb. sample can, which has a hopper bottom equipped with a gate. The can is placed above a M. & S. cone sample grinder, and the contents are fed through the gate into the grinder for reduction to ⅛ in. Discharge of the grinder is passed through a riffle until the 1,000-lb. sample is reduced to one of 75 lb. This last sample is placed in covered containers and sent to the assay office. The sample mill operations are largely automatic, and only one man is required in the mill. Owing to the fact that the machinery is arranged in a compact manner, he can readily see all the moving parts from one position.

In the main mill three tailing products are made—namely, rougher jig, table, and flotation tailing. Each of these is sampled every ten minutes by an air-operated sampler, of the same general construction as the sand tailing sampler shown in Fig. 8. This sampler was developed by the Butchart Manufacturing Company from one that I designed several years ago. The samplers in the sample mill and the head sampler are of the same general type, but are larger in size.

The three samplers in the main mill are operated through a master poppet-valve control mechanism, inclosed in a dustproof cast-bronze case and operating in oil. Inasmuch as the mechanism is driven through sprockets and chain from the mill line shaft, the samplers function whenever the mill is in operation. The essential part of this type of sampler, as in the head sampler and sample mill samplers, is an actuating cylinder, of the servomotor type, containing two opposing pistons attached to a common spindle. A gear rack cut on the spindle meshes with a gear segment fastened to a vertical pinion shaft. The sample cutter, of the slotted type usually employed in launder sampling, is attached to the pinion shaft by a short steel strap, which is bolted to the shaft and riveted to the cutter. Motion of the spindle in the actuating cylinder rotates the vertical pinion, and this, in turn, swings the cutter across the end of the launder. The interval between swings of the cutter is determined by the setting of the valves in the master control mechanism. These valves periodically divert the air pressure from one end of the actuating cylinder to the other end, thus causing the cutter to swing. A spout forming the lower end of the sample cutter discharges the sample into a container. The containers are collected daily, the employee who collects them and delivers them to the assay laboratory replacing each with an empty container. None of the mill crew handles the containers at any time or makes any adjustments to the sampling system.

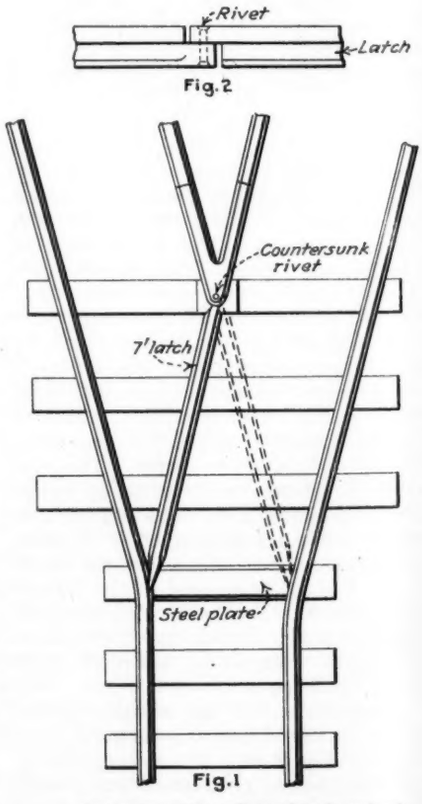
The economy of compressed-air sampling, particularly as applied to general mill operations, is noteworthy. As indicated in the preceding paragraph, any practicable number of samplers, each with an individual actuating cylinder, can be attached in parallel to one master control mechanism. Dimensions of the actuating cylinder and the air pressure employed can be varied to suit local conditions. At the Bird Dog mill the internal diameter of the cylinders and the stroke of each of the opposing pistons are each 2 in. Air pressure of 100 lb. per square inch is employed. Inasmuch as the samplers operate only once every ten minutes, the amount of compressed air consumed is small. Costs, therefore, are practically limited to first costs for equipment and its installation.

Installed cost of the compressed-air sampling equipment employed in the main mill of the Bird Dog plant, including the master control mechanism and drive, piping, and samplers, was $628.27. Owing to its reliability and simplicity of operation, particularly, the equipment has been an important factor in the achievement of outstanding metallurgical results at the plant.

■

New Underground Switch Effects Economies

IMPORTANT economies have been effected in the Butte district with a new type of underground switch. Construction of the switch, as illustrated in Fig. 1, consists of the usual lead and follower turnout rails, a standard frog, and but one latch; hence the designation "tongue" switch. The frog and latch points are machined as shown in Fig. 2, and are held together by means of a countersunk steel rivet. To make a perfect contact between the frog point and the outer rails, the latter are bent on a curve somewhat sharper than is the general practice with standard point or stub switches. A steel plate bolted onto the tie on which the latch rests provides an easy sliding surface for the latch and insures its perfect alignment.



Underground switch developed at Butte, Mont.

INDICATED HORSEPOWER CHART

THIS chart is designed to show the indicated horsepower of a double-acting steam cylinder when the cylinder dimensions, the mean effective pressure, and the piston speed or revolutions per minute are known. The brake horsepower will ordinarily run about 15 per cent less than that indicated. Both cylinder dimensions (diameter and stroke) are represented on the same scale.

A straight-edge connecting the known values of ***Length of Stroke*** and ***R.P.M.*** on their respective scales intersects the ***Piston Speed*** scale at its correct value. Align, then, this value of the ***Piston Speed*** with the known diameter of the cylinder, holding the point of intersection on the ungraduated scale. Swing the straight-edge about this point on the ungraduated scale to align it with the known value of the ***Mean Effective Pressure,*** reading the correct value of the ***Indicated Horsepower*** on that scale.

EXAMPLE: A duplex steam hoist of 22-in. cylinder diameter and 36-in. stroke, taking steam at 175 lb. per square inch gage, makes 80 r.p.m. If the cut-off is at ¾ stroke and the engine is condensing, what is the indicated horsepower?

PROCEDURE: With the aid of the ***Mean Effective Pressure Chart*** published in a previous issue, the mean effective pressure under the above conditions is found to be 109 lb. per square inch.

To find the piston speed, align 36 on the ***Length of Stroke*** scale and 80 on the ***R.P.M.*** scale, reading 480 ft. per minute at the intersection on the ***Piston Speed*** scale.

Align 109 on the ***Mean Effective Pressure*** scale with 22 on the ***Cylinder Diameter*** scale intersecting the ungraduated scale at a point about which the straight-edge is swung to align it and 480 on the ***Piston Speed*** scale, the intersection on the ***Horsepower*** scale reading 604. As this is the indicated horsepower of one cylinder, that of the engine, which is duplex, will be 1,208. The probable brake horsepower of the engine is 15 per cent less, 1,027, or about 1,000 hp.

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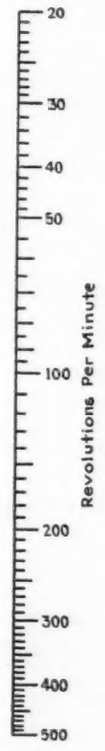
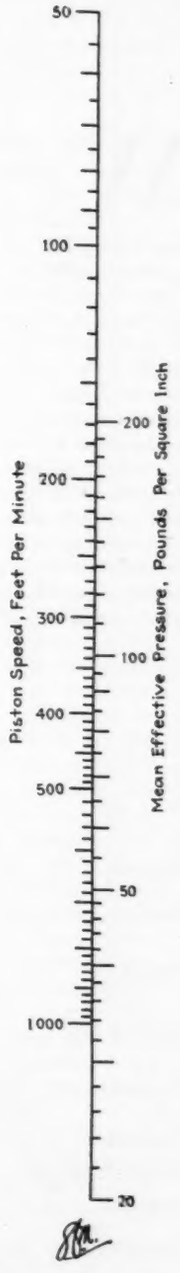
Sydney C. Mifflen





Group Research Among Gold Producers

A PLEA for co-operation in the attainment of a greater standardization of technical efficiency and economical operation among the producers of gold in northern Ontario, in emulation of successful efforts in this direction in the Witwatersrand district, Transvaal, and along the Golden Mile, in Western Australia.

R. M. P. Hamilton

WHETHER or no the rather hectic cycling of world economic events is caused by a deficiency in gold supply or, more plausibly, by a maldistribution of available gold, two things are evident: First, there is no need to fear an overproduction of gold, and, second, there is not, and will not be, anything competitive in the marketing of this essential metal. As a result of these conditions, we have a unique industry, in which it is to the advantage of all concerned to aid and co-operate with their neighbors in producing more gold at less cost per ounce.

According to estimates, $21,500,000,000 worth of gold has been produced in the past 450 years. More than half of this was produced since 1900, and of this amount, South Africa produced 36 per cent ($4,300,000,000). At present the annual production of the major gold-producing countries, in per cent of the world output, is approximately as follows: South Africa, 53 per cent; United States, 11 per cent; Canada, 10 per cent. Australasia, Brazil, Central America, Mexico, and Oceania all add important but smaller contributions. Annual world production of gold bullion in several recent years, in dollars, has been: 1915, $468,700,000; 1922, $319,400,000; 1928, $402,900,000; 1929, $407,000,000.

The major producer, South Africa, has been maintaining its tremendous share of the total production for a great many years. The country's possible ore reserves (500,000,000 tons) will probably keep its rate of output steady till 1936, after which year a 30 per cent decline in production may be expected. Canada's production is increasing rather steadily. The United States depends largely on base-metal ores for its gold production, the gold being obtained as a byproduct in the treatment of such ores. The two localities whose gold production have the greatest apparent possibilities for major increase in the immediate future are New Guinea and Russia.

South Africa has been an important source of metallurgical improvements since the beginning of the century, and it is noteworthy that those responsible for the gold-producing industry on the Rand have given hearty support to co-operative methods for reducing costs and increasing efficiencies. This co-operation is exemplified by the Rand Refinery, at Germiston, near Johannesburg, where bullion from 35 Rand mines is refined by a company owned jointly by the gold-mining companies of the district.

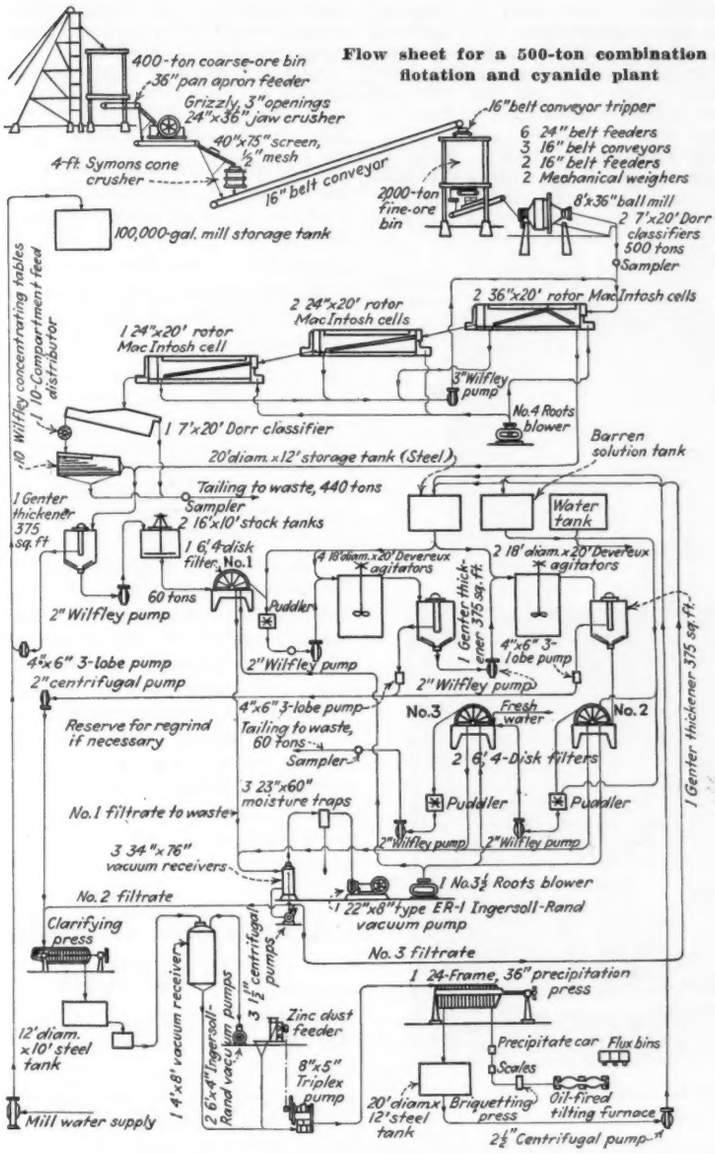
The Witwatersrand Co-operative Smelting Works, similarly owned and operated by the mining groups, receives all the byproducts from the various metallurgical plants on the Rand and treats them to recover the precious metals. Another department of the same subsidiary company handles the

Direct Operating Costs and Metallurgical Results of Northern Ontario Mills

Based On Company Annual Reports

Mill	Date of Close of Fiscal Year	Average Daily Tonnage of Ore Milled	Gold Value of Mill Heads, in Dollars	Recovery Per Ton, in Dollars	Tailing Value, in Dollars	Extraction, Per Cent	Cost per Ton of Ore Milled: Milling	Mining	Exploration and Development	Administration, Gen. & Misc.	Total Direct Cost
Hollinger	Dec. 31, 1928	4,982	$6.28	$6.02	$0.26	97.45	$0.75	$2.84	.....	$0.45	$4.04
	Dec. 31, 1929	4,268	6.33	6.09	.24	96.21	.66	2.85	.....	.44	3.95
McIntyre	Mar. 31, 1928	1,426	9.34	8.91	.43	94.68	.86	2.14	$0.75	.47	4.22
	Mar. 31, 1929	1,478	8.24	7.83	.41	95.02	.83	2.22	.80	.47	4.32
	Mar. 31, 1930	1,512	8.46	8.05	.41	95.15	.84	.....	.....	.....	.....
Vipond	July 31, 1926	177	9.74	8.77	.97	90.04	1.37	2.48	2.36	1.10	7.31
	July 31, 1927	263	8.21	7.36	.85	89.64	1.33	2.55	.79	.75	5.42
	July 31, 1928	230	8.12	7.46	.66	91.87	1.27	2.29	1.07	.51	5.14
	July 31, 1929	276	8.63	7.93	.70	91.89	1.21	1.96	1.07	.63	4.87
Kirkland Lake	Dec. 31, 1927	144	.....	8.99	.....	.....	.....	3.96(a)	1.60	.....	6.84
	Dec. 31, 1928	159	8.27	7.16	1.11	86.60	1.69	2.53	2.42	.....	6.64
	Dec. 31, 1929	147	7.32	6.60	.72	90.21	.....	4.54(a)	3.49	.....	8.03
Teck-Hughes	Aug. 31, 1927	315	.....	18.35	.....	.....	1.85	3.59	1.61	1.36	8.41
	Aug. 31, 1928	760	.....	16.28	.....	.....	1.48	2.59	.89	.68	5.64
	Aug. 31, 1929	910	.....	14.76	.....	.....	1.38	2.70	1.16	.69	5.92
	Aug. 31, 1930	945	18.89	17.81	1.08	94.8	1.24	2.52	1.43	.59	5.78
Lake Shore	June 30, 1929	1,009	.....	14.99	.....	.....	1.22	2.58	2.34	.20	6.34
	June 30, 1930	1,010	.....	.....	.....	.....	.99	2.71	.....	.....	5.85
Wright-Hargreaves	Dec. 31, 1929	.....	.....	.....	.....	.....	1.24	2.91	1.93	2.08	6.16
Sylvanite	Mar. 31, 1928 (b)	239	11.25	10.62	.63	94.40	1.64	3.19	.86	.10	5.79
	Mar. 31, 1929	194	.....	10.41	.....	.....	1.33	3.31	2.41	1.05	8.10
	Mar. 31, 1930	207	.....	9.16	.....	.....	1.33	3.14	2.74	.93	8.14
Howey	April, 1930 (c)	239	3.08(d)	2.88(d)	.20	93.51	.91	1.59	1.81	.39	4.73
	July and Aug., 1930 (e)	500	4.06	3.82	.24	94.05	.95	1.60	.32	.24	3.12

(a) Mining and milling. (b) Eight months' full operations. (c) Results for one month; operations began in April, 1930. (d) Disregarding values in process. (e) Results for two months.



Flow sheet for a 500-ton combination flotation and cyanide plant

metal scrap from the mines and mills, and, by electric-furnace melting, converts about 7,000 tons of scrap, annually, into useful forms, mostly into shoes and dies for the stamp mills.

The Rand Mines Laboratories are also jointly owned and operated by the mines of the district. This co-operative agency serves as an extremely valuable unit for the investigation of metallurgical problems, the development of ideas for practical application, and a general clearing house for information of benefit to those carrying out the metallurgical operations on the Rand.

We have found no possible loss to be suffered by gold producers helping one another to lower their costs and increase their extractions. We also find that South African operators, recovering approximately half the annual gold produced per year, have developed economically important and practical means of co-operating for their mutual benefit. Mines in other parts of the world, producing the other half of the annual gold production, should therefore, according to the foregoing criteria, derive material benefit by closer and better organized co-operation.

On account of local conditions or established practice, to adopt the community refinery system may not be feasible for many gold properties. Similarly, not always will a sufficient tonnage of scrap be available, or cheapness of power, or uses for the product, to warrant a community by-product recovery plant in districts other than the Rand. There is, however, nothing against and everything in favor of organized co-operation among gold producers the world over to study their current metallurgical problems and develop means of improving their present practices.

Efficiencies appear comparatively high when considered on a percentage basis, but when the same results are considered on the basis of dollars, or ounces of gold lost in tailing, the need for improvement is apparent. The percentage figures show that to accomplish the required improvements is becoming steadily more difficult. Because it is harder to improve our metallurgy, we have all the more need for co-operation.

The technical press does a great service in the dissemination of such information as is available and which is of sufficiently general interest to warrant it being published. Gold metallurgy has reached the stage when this method of disseminating information must be supplemented by active research work to aid the small groups of operators, working alone on the metallurgy of single plants, if they are to solve their current problems quickly and definitely and take full advantage of the collective knowledge of the art throughout the world.

In such an important center of gold production as northern Ontario, co-operation, such as has been developed in South Africa, appears to be lacking. In districts of less productive capacity, community research is not so practicable. Noteworthy, however, is the metallurgical research program that one of the important producing gold mines in Kirkland Lake has recently instituted. If this is necessary and beneficial for a mine producing at the rate of $2,500,000 annually, how much better it would be if the combined resources of the Porcupine and Kirkland Lake camps, together producing at the rate of about $40,000,000 per year, were directed toward the same study on a co-operative basis.

Early in 1929 the General Engineering Company drew up preliminary plans for a 500-ton combination flotation and cyanide plant in Canada. Chief among the reasons for returning to a straight cyanide plant was the lack of familiarity of cyanide men with the operations and possibilities of the combination process. Two years later, a gold mine is putting into operation a similar plant of 2,000 tons' daily capacity, the flow sheet and details of which have been successfully worked out by the mill superintendent at the property. Had there been a co-operative research arrangement in northern Ontario, the local metallurgists concerned in the first instance would have been familiar with the newer developments of flotation as applied to gold ores, and those responsible for the new plant in the second instance would have had a great deal of exact and useful information to call upon in solving their particular problem, avoiding the necessity of their carrying the load of the new development single-handed.

For the gold-mining industry, as a whole, one might suggest an organization in the nature of a "Guild," to which accredited companies or individuals would belong. The prosecution of research, its practical application, and the dissemination of pertinent information to members would come under the direction of this world-wide guild.

Should there be doubts as to the field for such an organization, the following notes concerning some of the current technical problems may be of interest:

Multiple-stage classification is showing signs of achieving economies. Must we wait till equipment firms persuade some large

operator to spend a lot of money studying his particular phase of this problem, or would it not be possible to shorten the time materially and equalize the burden required to establish the essential points about this important question?

With most of the precious-metal extraction taking place in the grinding circuits, would it be worth while grinding a little finer and filtering more often to save the capital cost of the numerous agitation layouts at present in vogue?

That additional solution of gold takes place during filtration is well known. How long will it take without organized research to determine where additional stages of filtration are uneconomical?

The addition of lead nitrate to pregnant solutions before clarification, to be followed by zinc dust precipitation, is uniform practice on the Rand. How long would it have taken this practice to go into effective operation in the 35 Rand mills if they had no central research body?

Sodium peroxide is proving useful in increasing extraction in several Canadian cyanide plants. Can the distant operator be saved some expense by fresh and definite knowledge of Ontario operators' experience?

A Kirkland Lake gold mine has accomplished an appreciable saving in costs by changing the method of handling black cyanide used in its mill. Some other plants might make the same saving if their metallurgists would call on the mill superintendent responsible for this change.

Aluminum blasting caps have been substituted for copper caps. Opinions vary as to whether this is helpful or otherwise. Who will determine the issue?

Individual operating staffs, engineering firms, and equipment firms will all continue to bring about improvements, but the time has arrived when the noncompetitive industries, such as that of gold production, cannot afford to overlook the benefits of fully organized cooperation.

■ ■ ■

Converter Operation at International Nickel's New Smelter

Flywheel motor-generator installation for operating converters

ONE of the interesting features of design found in the new 5,000-ton smelter of the International Nickel Company, at Copper Cliff, Ontario, is the turning mechanism of the eight 13x35-ft. Peirce-Smith converters. These units are turned through worm-and-spur gearing by 65-hp. General Electric Type M.D., series-wound mill-type motors, with E.C.&M. company brakes and automatic controllers. Limit switches are provided to prevent overtravel in either direction. The hoods are operated by 10-hp. motors and automatic control, with a separate master controller and limit switches to prevent overtravel.

Air for the converters is furnished by motor-driven blowers, the power supply for which is obtained over transmission lines from the hydro-electric plants and is subject to interruption at any moment. To prevent the matte from flowing back into the tuyères upon failure of air pressure, auxiliary means must be provided to turn the converters immediately whenever the power supply to the converter blowers fails, so that the tuyères will be brought above the matte level. The entire control scheme was designed with this requirement in view.

To furnish direct current for the converter-turning motors and the hood motors, two Canadian Westinghouse flywheel motor-generator sets are installed, each consisting of a 200-hp. 750-r.p.m. wound-rotor induction motor; steel-plate flywheel, 9 ft. in diameter, weighing 8 tons, and a 300-kw., 250-volt, d.c. generator, with automatic voltage regulator.

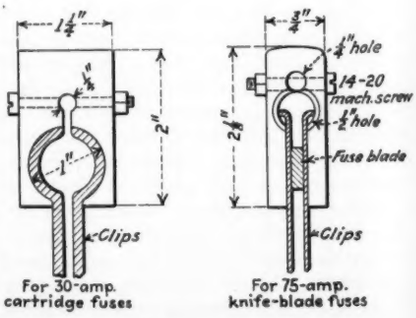
Under normal conditions, the converter man operates both converter and hood through master controllers, but should the power supply to the blowers fail or the air pressure for any reason be reduced below a safe value, a relay is operated, which, unless the tuyères are already above the matte level, immediately starts the hood motor and raises the hood clear of the converter. As soon as the hood is clear, it operates a limit switch which stops the hood, and at the same time starts the converter turning toward pouring position. When the tuyères are clear of the matte, the safe limit switch on the converter stops the converter motor. Should the power fail when the operator is turning a converter to the blow position, the converter would automatically stop and turn down to the safe limit.

The necessary energy for turning all the converters that may be blowing at the moment power fails is furnished by the flywheel of the motor-generator set, which is so proportioned that all of the eight converters may be turned simultaneously to the safe position, the speed of course falling during the operation, but the voltage being maintained by the regulator. Either of the motor-generators has sufficient capacity for the eight converters.

■

Attachable Clamps for Fuse Clips

LOOSELY held fuse cartridges or blades on switches and cut-out blocks—a frequent result of failing spring pressure on the holder clips—cause weak contacts of the metallic parts, with consequent heating and fuses blowing out below their capacity. Constant attention is necessary to assure smooth-running operations. To overcome this difficulty, Thomas C. Hulton devised the contrivance shown in the accompanying sketch. It consists of a clamp-like body, made of fiber, containing the necessary openings and slots to accommodate the clips holding the fuse cartridge or blade, over which the clamp is slipped while the switch is open. By tightening the small machine bolt traversing the ¼-in. hole, the pressure upon the holder clips can be regulated at will.



Training the Mining Engineer to Direct and Control

Francis G. Hill

ADVOCATING the inclusion, in current curricula at educational institutions, of distinct courses in scientific management.

INDUSTRIAL psychology serves to focus attention on the primary object of education: the development of an individual's capacities and endowments—mental, moral, or physical. But this is not its sole object: Education should develop toward a *known* end, whereby a mental attitude may be encouraged and knowledge imparted that will be of maximum value to the individual in his future field of endeavor. The purpose of this paper is to classify into its major objectives the work of the mining engineer, and to examine the curricula offered by universities, mining schools, and government bodies, in order to determine to what extent the courses are planned to train the faculties necessary for the attainment of these objectives.

The duties of a mining engineer fall into two major divisions—technical and managerial. The two fields overlap, but ample evidence is available to indicate that responsibilities are largely managerial as soon as appreciable advance has been made. As manager of a mine, he does not usually profess to be an expert geologist, metallurgist, mineralogist, or surveyor. When important technical projects or developments are under discussion, he calls for the advice and recommendation of specialists, and governs his actions accordingly. The only technical knowledge he requires is a grasp of basic scientific and engineering principles, so that he can follow intelligently the plans suggested.

In a paper recently read before the American Institute of Mining and Metallurgical Engineers, Mr. L. E. Young indicates some of the duties of the coal-mining engineer, as follows:

"He selects the men and officials for the operating force, including an adequate staff to supervise the training of all men in safe practices, first-aid, and mine rescue work.

"He organizes a program of wage incentives that will give an appropriate reward to faithful, efficient, and energetic employees.

"He studies the large economic questions of the coal industry, by reading and by participation in discussion with men in other industries, as well as with coal-mining engineers."

These duties are essentially those of a manager. From France comes evidence to the same effect. M. Fayol, the celebrated mining engineer, often referred to as the "French Taylor," avers that the successful mine manager should possess 60 per cent administrative ability and 40 per cent technical ability. If this be so, prevailing curricula are faulty. Most of the courses provided cover a wide range of technical subjects, but they give no grounding in management or administration. Professor Erwin Schell, in the March number of *The Technology Review*, gives results from a survey of the occupational duties of 6,000 graduates of engineering schools. He shows that 62 per cent of those who have been at work for 20 years or more have duties that are primarily administrative. These figures furnish additional evidence of the deficiency in present-day engineering curricula.

The growing complexity of modern industry is gradually exposing the defects in the education of the would-be mining engineer. Accumulation of new and detailed knowledge is favoring intense specialization. Endless channels are developing along which men must go if they are to keep pace with the best practice. Concurrently with such specialization, a parallel growth must occur in co-ordination and integration, which together crystallize as a separate function, that of direction and control. Can this function be found in one of the many channels to which reference has been made? Not easily. Specialization means that full-time attention must be paid to a particular function. It leads to a narrow outlook, whereas the quality most needed in the directing and controlling force is breadth. This force is, in essence, management, as distinct from such work as ore dressing, mining, surveying, or sampling. One who is to take such responsibility must have special training; he must be trained to deal with fundamentals, to see an industry in relation to other industries and in relation to its parts—in short, to see industry as a whole. To maintain that such training can best be acquired by a slow mastery of details in each of the channels traversed is wrong. The "old school" believed thus, believed that knowledge should be gained by long experience rather than by experiment or by studying the experiences of others; but such slow meandering tends to create a disposition to imitate rather than to investigate and initiate.

Why should training for management take so circuitous a route? Time is wasted when the scientific approach is lacking. An engineer who has been grounded in the principles of scientific management—who is energetic, able, keen—would be capable of assuming a responsible position in considerably less time than one similarly gifted but without the training. The specific education has given a wider view. His mind is continually active; no matter in what special capacity he is serving, he sees his relationship to the concern as a whole; he observes intelligently. He understands the significance of executive actions, and can judge their effect. Seeing himself a living part of the structure and not a mere pawn, he works with zest and enthusiasm to fit himself for higher supervisory work. His very awareness of what is happening around him is in itself a process of training that is denied his less well-trained co-worker. From his knowledge of the principles of management, he will be steadily conscious of the human element; he will realize the need for healthy human relationships, and he will work toward this end by trying to develop a spirit of co-operation between employer and employee. While he is making a special study of this field of intangibles, the other engineer is only dimly aware that such a field exists. A knowledge of the motives that influence men, a knowledge of intangibles, can help much toward the smooth running of the industrial machine.

Names can be cited of many successful managers who have had no specific training such as has been suggested, but their training is nevertheless there, gained through the school of long experience; and, unconsciously, the correct principles have been applied. But

training by experience means waste. Who would employ a cook who admitted that he had never been taught the principles of cooking, but was willing to learn by experience? Waste would be inevitable. The view that management is wholly an art is passing. Management is also a science. Its success depends on the application of fundamental scientific principles, scientific in the sense that they are part of a body of impersonal and highly systematized knowledge. Management as an art is the application of these principles, and, although skill in application is still the presiding genius in good management, the scientific aspects are real and vitally important.

Thus far an attempt has been made to show the need for a grasp of managerial principles in order to carry out managerial functions. A thorough understanding of these principles cannot follow from a few lectures. Unless the engineer has a wide range of critical knowledge, and experience with the problems of practical work, much of what is said will do no good. That is why the proposed modification of the university student's curricula can merely give him an approach to his work, a color to his inquiries, so as to facilitate his development. In the case of courses offered to those with technical experience, a change in those particulars especially indicated will give better results, because of the wider knowledge and broader intelligence possessed by those who have worked with men and machines.

Self-made men today are not self-made in the old sense; they are those who have sought knowledge and mastered it. Even as the principles of physics and chemistry can be learned from lectures, from books, from general reading, so can be acquired a knowledge of the principles of management, principles that need no longer be learned by chance experience. They are at hand in the books of such writers as Taylor, Emerson, Lewisohn, Williams, and Gilbreth; and that is why a man must have a seeking mind—ability to assimilate and to apply ideas.

Ideas must precede constructive effort; and ideas become vigorous and alive—they most easily acquire hands and feet—when they spring from systematic, logical, and critical reasoning, as opposed to loose and haphazard modes of thought. The increasing degrees to which system and order are creeping into industry call for a similar system and order in ideas affecting industry. And much will have been accomplished in this direction when a clear differentiation of functions has been made, and educational courses have been patterned to develop the facilities that are needed.

■ ■ ■

Charging Grinding Rods

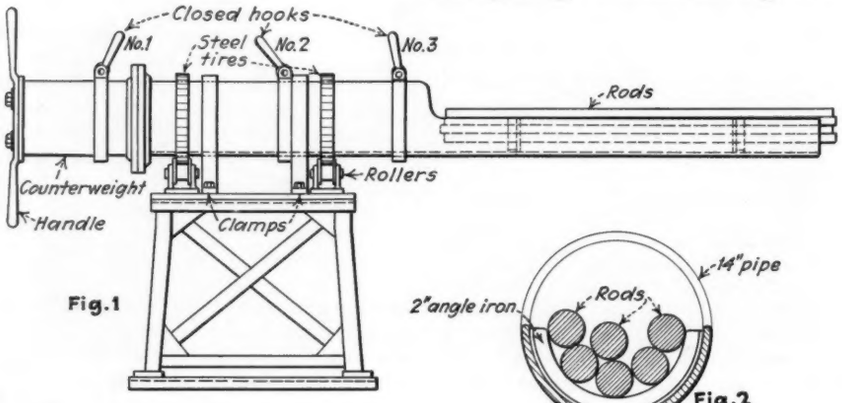


Fig.1

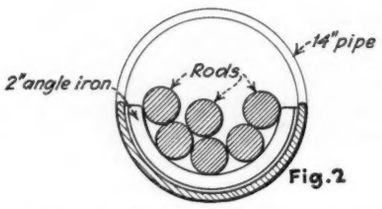


Fig.2

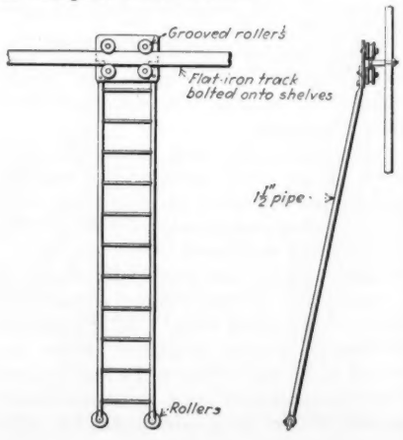
A LABORIOUS and dangerous task at the concentrator or mill employing rod mills is the periodical charging of new grinding rods. When performed by hand, or without the aid of a special contrivance, a large force of men is required, involving considerable expense and the danger of crushed fingers or other accidents caused by falling rods. To overcome this hazard, as well as to simplify and expedite charging operations with a maximum factor of safety, the Moctezuma Copper Company, Nacozari, Sonora, Mexico, developed the device shown in Fig. 1 of the accompanying sketch. It consists of two main parts: (1) the upper or revolving body, made of 14-in. steel pipe. This contains a cutout deposit to accommodate the rods, and is fitted with two semicircular 2-in. angle irons to facilitate the removal of the steel cables holding the rods, as illustrated in Fig. 2. (2) Two welded-on steel tires; a bolted-on counterweight, with its turning handles; the closed hooks Nos. 1, 2, and 3; and the structural steel base, with its four steel rollers and two U-shaped strap-iron clamps to anchor the revolving part to the base.

The rods are dumped into the mill in the following manner: From the stockpile, six rods at a time are placed by the overhead crane into the open deposit of the revolving part, the hooks of the chains suspended from the crane hook being attached to the closed hooks Nos. 1 and 3. Then the entire device is raised, and the end containing the rods is inserted into the open head of the mill and lowered again. Next, the operator revolves the upper body by turning the handles attached to the counterweight, and so dumps the rods into the mill. The unloaded device is withdrawn from the mill by placing the chain hooks into hooks Nos. 1 and 2. It is then reloaded, and again inserted and discharged as before. This operation is repeated until the mill contains the desired amount of rods.

■ ■

Metal Ladder Proves Useful and Efficient

AN INNOVATION at the tool room of the New Cornelia mines of Calumet & Arizona, at Ajo, Ariz., is a movable ladder that affords the operator rapid access to the shelves beyond his reach, and, at the same time, expedites the dispatching of materials. The ladder proper, made of two lengths of 1½-in. pipe and welded-on ½-in. round iron spokes, is bolted to the trolley head, consisting of four grooved rollers attached to a support plate, which operates on a track of flat iron along the entire length of the shelves, as shown in the accompanying sketch. When not in use, the ladder is rolled into the assigned corner, requiring only a minimum amount of room space, because of its compact construction.



Mineragraphic Aid in the Concentration of Manganiferous Iron Ores

W. H. Coghill[1],
Warren Howes[2],
and S. R. B. Cooke[3]

THE Mississippi Valley Experiment Station of the U. S. Bureau of Mines, in co-operation with the Missouri School of Mines and Metallurgy, Rolla, Mo., has been studying the beneficiation of the high silica manganiferous iron ores of the Cuyuna district, Minnesota, with the object of reducing the insoluble content to 10 per cent or less. These experiments have shown[4] that roasting and magnetic concentration are unsuccessful.

The silica content of some of the cleaner ores can be reduced within commercial limits by crushing to 8 to 10 mesh, classifying and tabling the coarse sizes, and floating the fines. Separation, however, is not as clean-cut as in the similar treatment of sulphide ores, nor are all the Cuyuna ores equally amenable to the process.

Two ores representing a large tonnage of material that is now non-commercial were given attention. These ores varied somewhat as to their chemical composition, but a visual examination gave the impression that a process that would be capable of concentrating one would also work successfully on the other. Laboratory tests using tabling and flotation processes showed this preliminary conclusion to be in error. One ore, hereafter referred to as ore *A*, gave good results when tabled, but when crushed to flotation size only low-grade concentrates could be produced. The other ore, designated as ore *B*, could not be tabled satisfactorily, but good concentrates could be made by flotation.

The natural explanation for the differences in the tabling properties of the two ores would be that in the troublesome one the minerals were more intimately locked; but the reason why the cleanest ore gave higher silica concentrates by flotation was not readily apparent.

A microscopic study of these ores was undertaken to obtain information on the mineral associations which caused these difficulties, in hope that a knowledge of the cause might lead to the development of remedial measures. As already here stated, ore *A* was amenable to table concentration but did not give good

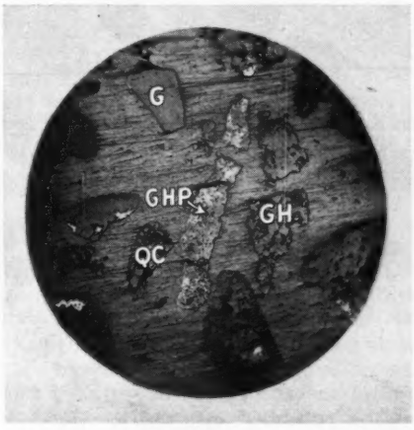


Fig. 1—Polished section of Ore "A," 35- to 65-mesh portion, float-and-sink fraction less than 2.95 sp.gr., briquetted. "G," siliceous gangue; "Q," quartz; "C," carbonate; "H," hematite; "P," psilomelane. The matrix is bakelite. Magnification: 50x.

flotation results, whereas ore *B* gave merchantable grade concentrates only by flotation. Their partial analyses are shown in Table I.

Table I—Analyses of Ores *A* and *B*

Ore	Assay, Per Cent				
	Fe	Mn	Insol.	SiO_2	P
A.....	32.1	15.0	20.8	18.6	0.034
B.....	26.5	22.5	23.7	22.3	.035

Microscopic examinations were made of polished sections[5] and the results recorded in photomicrographs[6] and *camera lucida* drawings[7].

Examination of rock fragments of crude ore is unsatisfactory because of the difficulty of securing individual pieces representative of the ore as a whole. By crushing large samples, mixing, quartering, and briquetting the resulting fraction[8], a composite of the ore may be secured in one section.

However, in the heterogeneous mass of mineral particles resulting from such treatment, to overlook minor details, especially minerals present in small amounts, is easy. By crushing the ore and fractionating the products according to the specific gravity of the grains[9], segregation is obtained. These "segregates" offer a means of more accurate

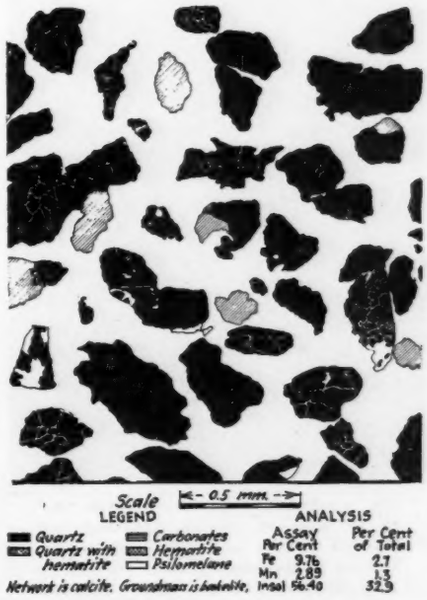


Fig. 2—Ore "A" fraction less than 2.95 sp.gr. *Camera lucida* drawing.

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[2]Assistant research metallurgist, Missouri School of Mines and Metallurgy, Rolla, Mo.

[3]Research graduate student, Missouri School of Mines and Metallurgy, Rolla, Mo.

[4]DeVaney, F. D., and Clemmer, J. B.: "Concentration Tests on the Maganiferous Iron Ores of the Cuyuna District, Minnesota." U. S. Bureau of Mines Report of Investigation No. 3045, 1930, 9 pages.

This paper presents the results of work done under a co-operative agreement between the U. S. Bureau of Mines and the Missouri School of Mines and Metallurgy, Rolla, Mo. Published by permission of the director, U. S. Bureau of Mines.

[5]Davy W. Myron, and Farnham, C. Mason: "Microscopic Examination of the Ore Minerals." New York City, 1920, 154 pages.
Murdock, Joseph: "Microscopical Determination of the Opaque Minerals." New York City, 1915; 165 pages.
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[6]Eastman Kodak Company: "Photomicrography." 1925, 44 pages.

[7]Johannsen, Albert: "Manual of Petrographic Methods." New York City, 2d edition; 1918, pp. 296-299.
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[8]Head, R. E., and Slavin, M.: "A New Development in the Preparation of Briquetted Mineral Grains." University of Utah, Technical Paper No. 10, 1930, 11 pages.

[9]Sullivan, John D.: "Heavy Liquids for Mineralogical Analyses." Technical Paper 381, U. S. Bureau of Mines, 1927, 25 pages.
O'Meara, R. G., and Clemmer, J. Bruce: "Methods of Preparing and Cleaning Some Common Heavy Liquids Used in Ore Testing." U. S. Bureau of Mines Report of Investigation No. 2897, 1928, 6 pages.

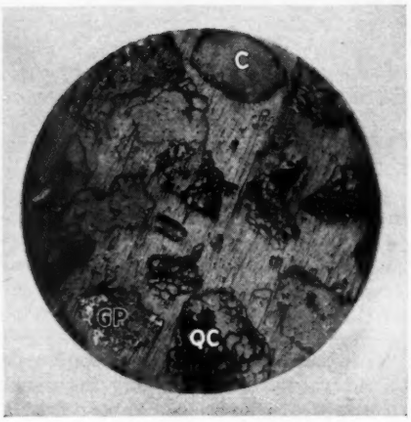


Fig. 3—Polished section of Ore "A," 35- to 65-mesh portion, float-and-sink fraction 2.95 to 3.25 sp.gr., briquetted. "G," gangue; "Q," quartz; "C," carbonate; "H," hematite; "P," psilomelane. Magnification: 50x.

examination of the ore, inasmuch as minor minerals are brought into prominence and particles of the same mineral can be more easily compared with each other than if highly diluted by different materials. In addition, the microscopic analysis of such specific-gravity fractions will give a preliminary idea regarding the amenability of the ore to concentration.

Because of the obvious advantages of this method, the study was conducted on fractionated ore. After crushing to 20 mesh, the 35- to 65-mesh portion was separated into four fractions by means of the following heavy liquids: acetylene tetrabromide, 2.95 sp.gr.; thallium formate, 3.25 sp.gr.; thallium malonate-formate, 3.66 sp.gr.

The briquetted specimens were prepared for examination by grinding to a flat face on a vertical emery wheel; smoothing gradually by grinding, in turn, on a glass plate with 600 carborundum, on a horizontal iron wheel (revolving at 150 r.p.m.) with 15 M carborundum, and on another iron wheel with levigated alumina; then polishing by rubbing on a smooth glass plate with levigated alumina and soap, and finally on a horizontal, poplin-covered lap (revolving at 3,600 r.p.m.) using rouge as the polishing agent.

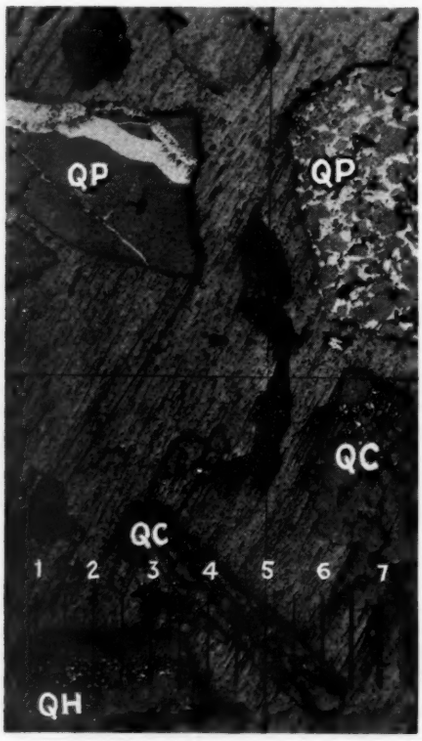


Fig. 4—Polished section of Ore "A," 35- to 65-mesh portion, float-and-sink fraction 2.95 to 3.25 sp.gr., briquetted. Legend is the same as that for Fig. 3. Magnification: 100x. The smallest divisions on the superimposed micrometer scale each equal the opening in a 400-mesh screen.

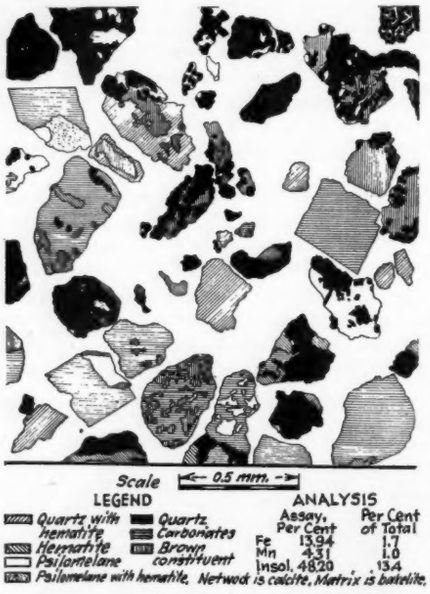


Fig. 5—Ore "A" fraction 2.95 to 3.25 sp.gr. *Camera lucida* drawing.

Hematite and psilomelane are the predominating ore minerals. Small quantities of manganite, pyrolusite, and limonite were also found. The hematite is micaceous in habit. It occurs finely disseminated in widely varying proportions in quartz, carbonate minerals, and psilomelane. Psilomelane occurs disseminated in a manner similar to hematite, although, on the whole, coarser-grained in structure.

The most important gangue minerals are quartz, feldspar, and mixed carbonates. Quartz predominates throughout both ores. Feldspar occurs principally in large grains, sometimes partly replaced by psilomelane. The carbonates are often found as cementing material for very fine quartz grains, and sometimes contain hematite, psilomelane, manganite, and pyrolusite. Calcite is the predominant carbonate, with minor amounts of rhodochrosite and siderite.

The mineral constituents of the two ores are essentially the same, although their proportions differ. The greatest variation is in the carbonate content.

Ore *A* is amenable to table concentration, and this could be predicted from the assay of the float-and-sink fractions, as given in Table II.

The lightest fraction, lighter than 2.95 specific gravity, is composed almost entirely of siliceous gangue. Some of it is badly shattered and recemented by carbonates. (Note *QC* in Fig. 1; also black particles with white network in Fig. 2.) Hematite and psilomelane occur in small amounts disseminated in the gangue (see Figs. 1 and 2). Obviously, this fraction would be easily rejected by gravity concentration without great loss of manganese and iron. It contains about one-third of all the insoluble matter.

Most significant regarding the fraction having a specific gravity between 2.95 and 3.25 is the increase over the preceding portion in the amount of carbonate present. In the lightest fraction it occurred only as cementing material in quartz grains. In this fraction it is found not only in this manner but also

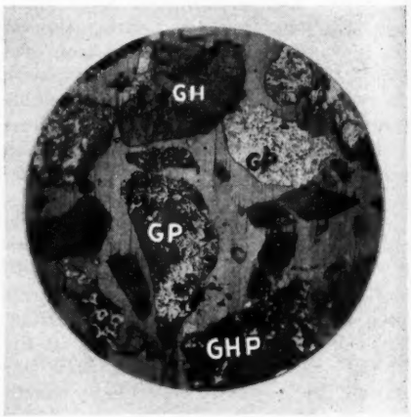


Fig. 6—Polished section of Ore "A," 35- to 65-mesh portion, float-and-sink fraction 3.25 to 3.66 sp.gr., briquetted, showing intimate interlocking of "G," siliceous gangue; "H," hematite; "P," psilomelane. Magnification: 50x.

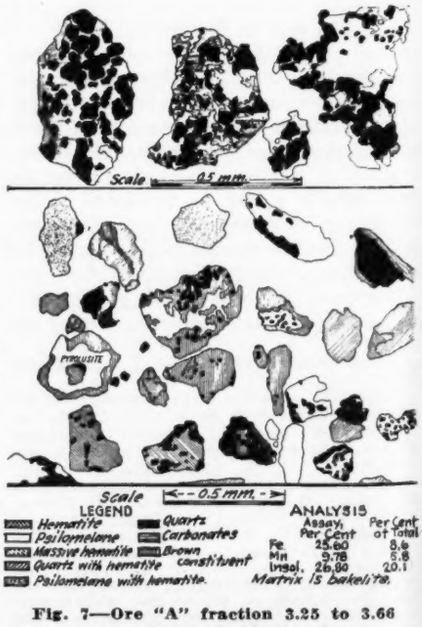


Fig. 7—Ore "A" fraction 3.25 to 3.66 sp.gr. *Camera lucida* drawing.

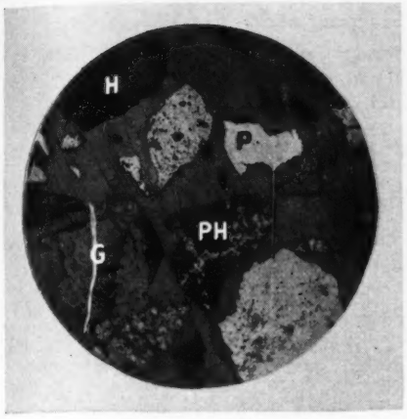


Fig. 8—Polished section of Ore "A," 35- to 65-mesh portion, fraction heavier than 3.66 sp.gr., briquetted. "G," siliceous gangue; "H," hematite; "P," psilomelane. Magnification: 50x.

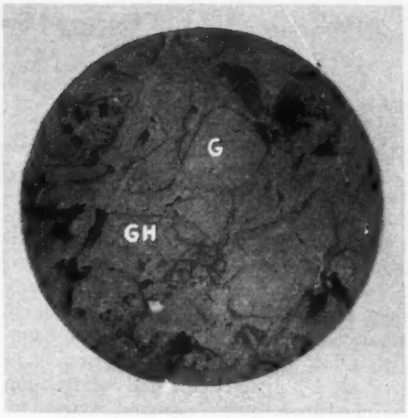


Fig. 10—Polished section of Ore "B," 35- to 65-mesh portion, float-and-sink fraction less than 2.95 sp.gr., briquetted. "G," siliceous gangue; "H," hematite. Magnification: 50x.

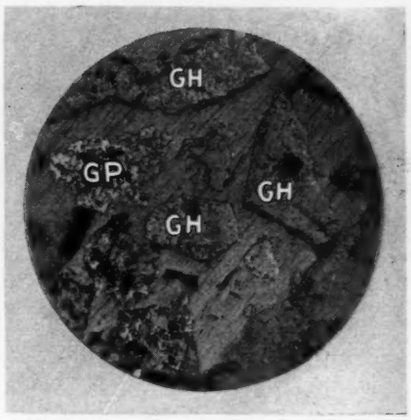


Fig. 12—Polished section of Ore "B," 35- to 65-mesh portion, float-and-sink fraction 2.95 to 3.25 sp.gr., briquetted. "G," gangue; "H," hematite; "P," psilomelane. Magnification: 50x.

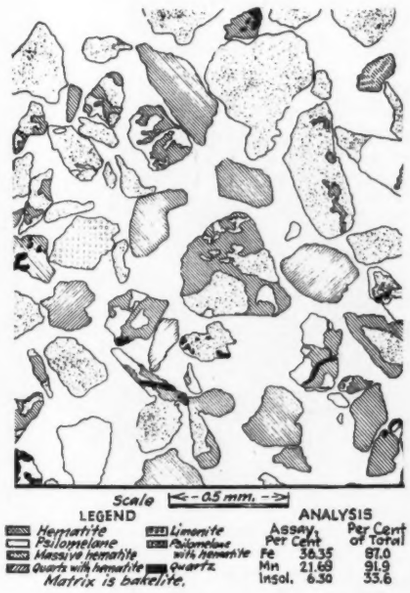


Fig. 9—Ore "A" fraction more than 3.66 sp.gr. *Camera lucida* drawing.

as distinct grains, often showing the characteristic rhombohedral outlines of the carbonate minerals (see Fig. 5). Inasmuch as calcite has a specific gravity less than the lower limit of this fraction, and rhodochrosite and siderite more than the higher limit, the carbonate present is probably a molecular mixture of at least two, and perhaps more, of these carbonates.

The presence of a considerable amount of carbonate intimately locked with gangue minerals in this fraction shows why flotation methods failed on this ore: The flotation reagents used have a definite tendency to float the carbonate minerals. Thus, the carbonates are concentrated in the froth and carry with them a sufficient amount of locked gangue particles to give a relatively high silica concentrate.

Psilomelane and hematite occur intimately intergrown with the quartz in slightly greater amounts than are found in the lightest fraction (see Figs. 3 and 4). This fraction could be cut from the ore by gravity concentration, although there would be some loss of manganese and iron. This procedure would eliminate the troublesome quartz grains that are cemented with calcite.

The most intimate locking of minerals occurs in the fraction between 3.25 and 3.66 sp.gr. The carbonate grains of the preceding fraction and the carbonate-cemented quartz do not occur in this "segregate." Nor are the free particles of psilomelane and hematite present that are found in the heaviest fraction. Instead, all minerals occur closely interlocked in all possible combinations. This is clearly shown in Figs. 6 and 7.

That a fraction of this kind will cause trouble in treatment is obvious. Losses of iron and manganese will be high if this material is sent to waste, but the high quartz content prohibits its use as part of the concentrate. Furthermore, the intimate mixture of heavy ore minerals and light gangue gives the particles an intermediate specific gravity which causes trouble in gravity methods of treatment. Middlings would require regrinding.

Microscopic measurement of the grain size of the minerals shows that grinding to 100 mesh would liberate a goodly part of this mineral, some of

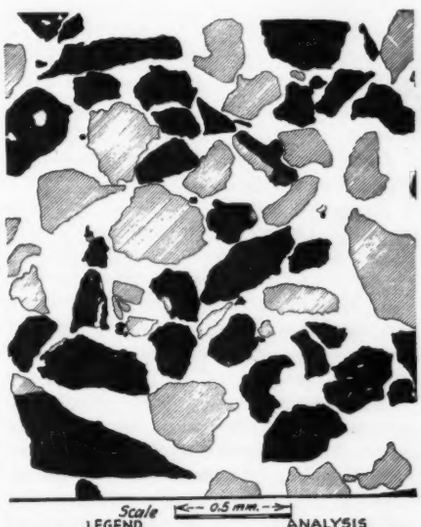


Fig. 11—Ore "B" fraction less than 2.95 sp.gr. *Camera lucida* drawing.

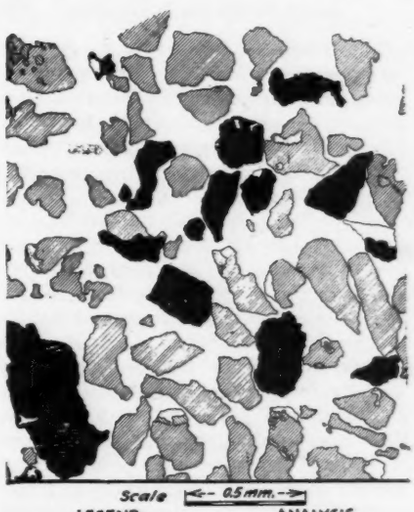


Fig. 13—Ore "B" fraction 2.95 to 3.25 sp.gr. *Camera lucida* drawing.

Table II—Assay of Float-and-Sink Fractions of 35- to 65-Mesh Ore *A*

Product	Per Cent by Weight	Assay, Per Cent Fe	Assay, Per Cent Mn	Assay, Per Cent Insol.	Per Cent of Total Fe	Per Cent of Total Mn	Per Cent of Total Insol.
Float on 2.95 sp.gr.	8.4	9.76	2.89	56.40	2.7	1.3	32.9
2.95 to 3.25 sp.gr.	4.0	13.94	4.31	48.20	1.7	1.0	13.4
3.25 to 3.66 sp.gr.	10.8	25.60	9.78	26.80	8.6	5.8	20.1
Sink in 3.66 sp.gr.	76.8	36.35	21.69	6.30	87.0	91.9	33.6
Composite	100.0	32.10	18.13	14.40	100.0	100.0	100.0

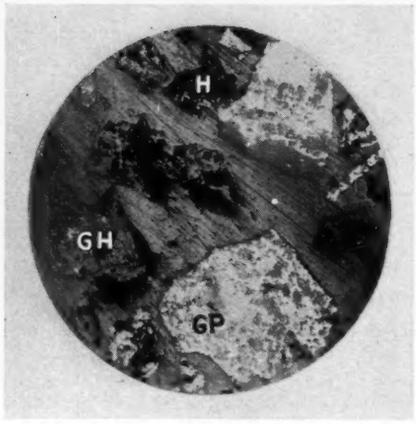


Fig. 14—Polished section of Ore "B," 35- to 65-mesh portion, float-and-sink fraction 3.25 to 3.66 sp.gr., briquetted. "G," gangue; "H," hematite; "P," psilomelane. Magnification: 50x.

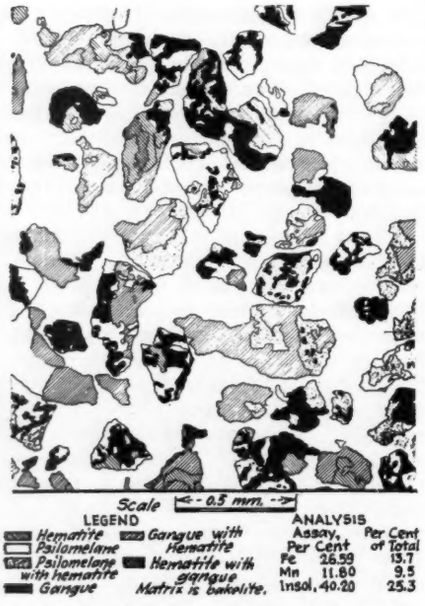


Fig. 15—Ore "B" fraction 3.25 to 3.66 sp.gr. *Camera lucida* drawing.

which could be recovered by gravity concentration and the remainder by flotation. Supplementary flotation after gravity concentration would be easier than all-flotation, because gravity work would remove a part of the cemented quartz carbonate grains.

In the heaviest product, that heavier than 3.66 specific gravity, we find, for the first time, distinct grains of psilomelane and hematite. Much of the psilomelane contains micaceous hematite in a finely divided form. Quartz occurs in minor amounts, but usually locked with the psilomelane and hematite. This is shown in Figs. 8 and 9. Obviously, this will produce a satisfactory concentrate of hematite and psilomelane by gravity methods of concentration. However, the intimate intergrowth of the ore minerals prevents the separation of the iron and manganese.

Microscopic examination of ore *A*, crushed and separated into fractions of a limited range in specific gravity, shows

Table III—Assay of Float-and-Sink Fractions of 35- to 65-Mesh Ore *B*

Product	Per Cent Weight	Assay, Per Cent Fe	Assay, Per Cent Mn	Assay, Per Cent Insol.	Per Cent of Total Fe	Per Cent of Total Mn	Per Cent of Total Insol.
Float on 2.95 sp.gr.	7.2	10.36	1.56	79.40	2.5	0.6	23.6
2.95 to 3.25 sp.gr.	8.5	20.92	4.02	61.40	6.0	1.8	21.5
3.25 to 3.66 sp.gr.	15.3	26.59	11.80	40.20	13.7	9.5	25.3
Sink in 3.66 sp.gr.	69.0	33.37	24.30	10.40	77.8	88.1	29.6
Composite	100.0	29.58	19.06	24.27	100.0	100.0	100.0

that the size of the individual ore-mineral grains is such that it is impossible to free them from each other. Their intimate interlocking had already been proved by roasting and magnetic separation tests[4]. Float-and-sink separation has shown that it is possible to produce by gravity methods a fraction enriched in iron and manganese and low in silica. Good concentrates were made by gravity concentration.

Flotation processes which make use of the fatty acids as reagents will not give clean concentrates if the entire ore is treated, owing to the tendency of these reagents to float carbonates. These carbonates, being intimately associated with gangue, tend to give high silica froths. Flotation of reground table middlings should not be so difficult, as a result of the removal of a greater proportion of the troublesome carbonates in the table tailings.

Examination of Ore *B*

Ore *B* did not respond to tabling at the customary sizes, as only high silica concentrates could be made. However, unlike ore *A*, this ore when ground to flotation size gave concentrates of good grade. The assay of float-and-sink separations of ore *B* is given in Table III.

Like the lightest fraction of ore *A*, the part of ore *B* lighter than 2.95 sp.gr. is composed almost entirely of siliceous gangue. However, the shattered grains recemented by carbonate, found in ore *A*, are entirely lacking in this material. The most significant component from the ore-dressing standpoint is the rather large amount of ferruginous chert. This can best be seen in Fig. 11. Gravity concentration would easily reject this material with little loss of ore, but, inasmuch as the ferruginous chert would probably be attracted by a magnet, roasting and magnetic concentration is entirely out of the question; roasting and magnetic concentration had given iron concentrates high in silica.

The fraction with a specific gravity between 2.95 and 3.25 is noteworthy chiefly for the lack of clean mineral grains. Figs. 12 and 13 show that psilomelane and hematite are finely disseminated through the gangue particles. This fraction of ore *B* differs from the corresponding part of ore *A* (see Figs. 3, 4, and 5) by the much finer dissemination of the iron and manganese, and by the lack of carbonates that were the most characteristic feature in this cut of ore *A*. While this fraction would be partly rejected by gravity concentration, losses of iron and manganese would be incurred.

[4] *Op. cit.*

Minerals in the fraction between 3.25 and 3.66 sp.gr. are by far the most intimately locked of all of the fractions of either ore *A* or ore *B*. (See Figs. 14 and 15.) This explains the great difficulty in concentrating this material by tables. Losses would be high if the fraction were run to waste. On the other hand, excessive insoluble matter prohibits its use as a concentrate.

The heaviest fraction, that heavier than 3.66 sp.gr., carries considerably more gangue than the corresponding product of ore *A*. On the other hand, there is more relatively clean psilomelane (see Figs. 16 and 17). However, interlocking of hematite,

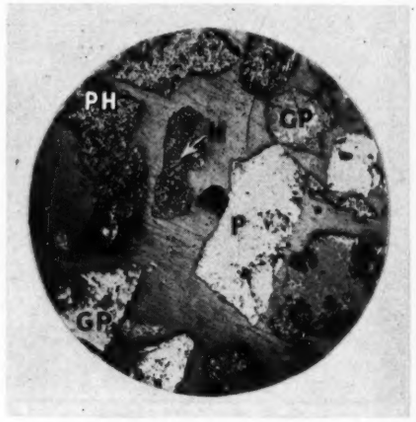


Fig. 16—Polished section of Ore "B," 35- to 65-mesh portion, fraction heavier than 3.66 sp.gr. briquetted. "G," gangue; "H," hematite; "P," psilomelane. Magnification: 50x.

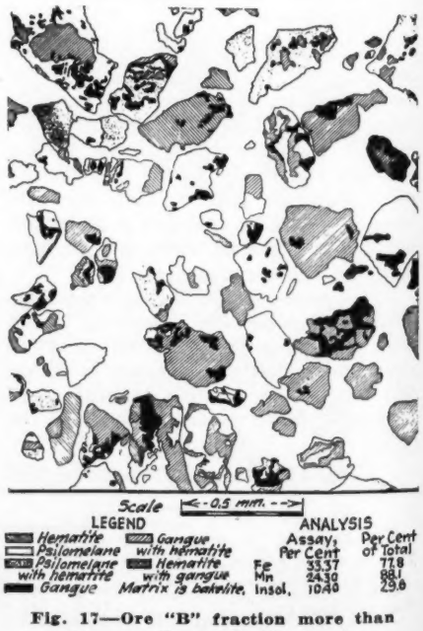


Fig. 17—Ore "B" fraction more than 3.66 sp.gr. *Camera lucida* drawing.

psilomelane, and gangue is still the rule rather than the exception. This fraction could be separated from the rest by gravity methods, but its high gangue content considerably reduces its value. Its nature shows that grinding to flotation size is desirable, and flotation tests made on the fraction were found to be successful.

The extreme interlocking of the minerals in the fractions of all specific gravities of ore *B* makes obvious the impossibility of freeing the individual mineral grains at tabling size.

Magnetic concentration is impossible because of the presence of finely disseminated hematite in most of the gangue. A quartz grain containing as little as 10 per cent of iron would be drawn into a magnetic concentrate. Inasmuch as a large part of the ferruginous chert in this ore would therefore be found in the concentrate, sufficient reduction in the amount of silica to meet furnace requirements could not be effected by the use of magnetic methods.

The extreme locking of the minerals in this ore makes grinding to flotation size necessary. Absence of troublesome carbonates makes the concentration of this material by flotation attractive. Laboratory tests bear out this premise, as it was found possible to concentrate this material satisfactorily by flotation.

Summary and Conclusions

Two manganiferous iron ores, representative of large deposits in the Cuyuna district, in Minnesota, were studied by table concentration, flotation, roasting and magnetic separation, and mineragraphic methods. Both ores were quite similar in composition and appearance.

Ore *A* had given satisfactory concentrates when tabled, but it gave flotation concentrates too high in silica. Ore *B* gave high silica concentrates when tabled, but when finely ground, responded readily to flotation and gave a good grade of concentrate. A microscopic study of each ore was made so as to explain this anomaly.

The microscopic study showed that ore *A* did not give good flotation concentrates, because of the presence of carbonates intimately associated with siliceous gangue; the carbonate was floatable and carried the locked silica particles along with it into the concentrate. The resulting concentrate was therefore too siliceous to be of value. Ore *A* responded to table concentration because the greater portion of the manganese and iron minerals were fairly well liberated from the gangue at table size. The siliceous carbonates gave no trouble in tabling, because they could be largely eliminated in the tailing.

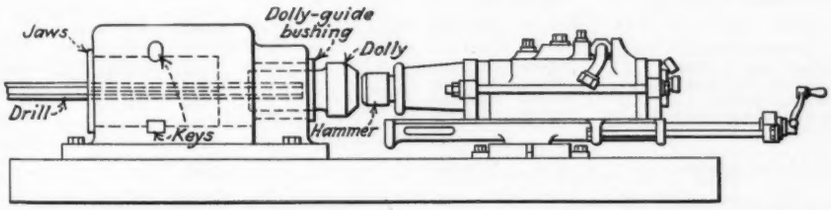
Ore *B* could not be tabled satisfactorily because of the intimate locking of the ore minerals with the quartz gangue. Grinding to flotation size was sufficient to unlock the ore minerals from the gangue, and the absence of the troublesome siliceous carbonates made it possible to obtain a satisfactory concentrate by flotation.

Microscopical examination disclosed the fact that the iron and manganese minerals in both ores were closely interlocked. This explained why it was impossible to secure a satisfactory separation between the two by the removal of the iron magnetically from roasted ore. The microscope was used to make visible the cause of the trouble encountered in table concentration, flotation, and roasting and magnetic separation.

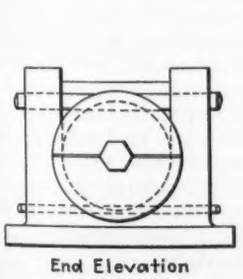
This example is but one of the many instances in present-day ore-dressing practice in which the microscope has been a means of outlining treatment methods or diagnosing difficulties in existing flow sheets.

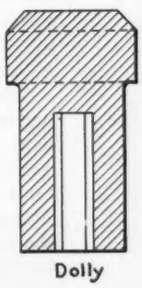
■ ■ ■

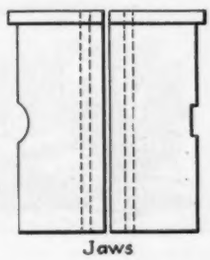
Simple Shanking Device



AT SMALL mining properties or prospects, in the development stage, many operations, including the sharpening and shanking of drills, must be performed manually, owing to the lack of special machines and tools. Particularly, the hand-shanking of machine drills presents many difficulties and considerable expense. When jackhammer drill steel is used, this operation can be performed mechanically with the simple contrivance shown in the accompanying sketch. The device, mounted together with an old rock drill equipped with a special steel hammer upon a heavy wooden block, consists of a sturdy cast-iron or steel frame containing a press-fitted dolly guide bushing, a tempered-steel dolly with its hexagonal opening, and two steel jaws which, with the aid of two tapered steel keys, hold the drill to be shanked securely in place. The operation is simple: The drill is first placed between the two steel jaws, and the heated end inserted into the hollow of the dolly. Then the jaws are tightened by advancing the upper or oval key with a few hammer blows, after which the rock drill is set in operation and the shank made. Removed from the vise, the shank is again heated, and the deformed hole rectified with a thin steel punch. All parts can be made at low cost at the blacksmith shop, provided a lathe is available; or, they may be ordered, according to specifications, from the factory.


End Elevation

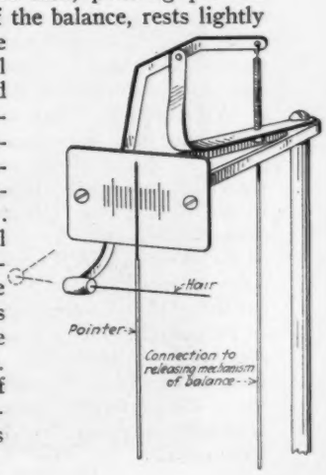

Dolly


Jaws

■

Improved Release for Assay Balances

KICKS and excessive swinging of the pointer of an assay balance, causing much delay in weighing, may be prevented by the simple arrangement shown in the accompanying sketch, writes John Herman, of Los Angeles, Calif. A horse hair, pointing parallel to the beam of the balance, rests lightly against the pointer, until the beam and the outer knife-edges are released by turning the actuating knob. When all edges are released, the hair moves out, setting the pointer free. Economy of time in weighing operations is claimed.



World Copper-Refining Capacity

Percy E. Barbour

NO DATA are available for the copper-refining capacity of the world, but existing capacity, and that planned or under construction, seem ample for any demand that may be reached before 1940. The refining capacity of the Western Hemisphere may be estimated with fair accuracy. That of the United States is shown by the accompanying table to be about 2,056,000 tons per annum. The largest annual production in this country was 1,542,238 tons, in 1929, so the refining capacity at present is much overbuilt. Until recently, of course, Canadian production had to be refined largely in the United States.

The refining capacity of South America is shown in the table as 365,000 tons. South America's peak production of those companies having refineries, in 1929, was 319,283 tons. The mines of Chile are capable of furnishing much more copper than they have heretofore produced, so the full refinery capacity may be utilized sooner than in North America.

Canada's refinery capacity includes two new plants. The Ontario refinery, at Copper Cliff, to treat principally International Nickel's copper, was completed in 1930, but has so far not operated at capacity. The Canadian Copper Refiners' plant at Montreal East has just been completed and gone into operation. Both of these plants can easily be expanded, but their present capacity seems adequate for some years.

The capacity of the individual foreign refineries is not available, but it is evident that it is ample for any tonnages reached in the past, and plants are already under construction or planned in Europe and Africa to take care of the new African production. A new plant at Wilhelmsburg, near Hamburg, Germany, has been constructed, with a capacity of 20,000 metric tons, and was practically complete at the end of 1930. In Sweden, a new electrolytic plant is under construction to treat the output of the Boliden and Rannskor mines, but it is relatively small, having an annual capacity of only about 7,000 metric tons. In Belgium, the Société Générale Metallurgique de Hoboken, subsidiary of Union Minière, is expanding the capacity of its electrolytic copper refinery at Hoboken, Belgium, to 110,000 metric tons annually, or about 121,000 tons of 2,000 lb. The company handles Union Minière's blister as well as some custom copper. During the fiscal year 1929-30, production was 67,000 metric tons. As Union Minière also produces refined copper from its Panda leaching plant, which has an annual capacity of 30,000 metric tons, very little if any of the Katanga output, when the Hoboken plant extension is completed, will have to be shipped to the United States for refining.

Refinery Capacity, North and South America

In Tons of 2,000 Lb.

	E. & M. J. Estimate 1929	1931
United States		
Electrolytic Refineries		
Baltimore, A. S.& R.	400,000	400,000
Laurel Hill, Nichols	250,000	300,000
Raritan, Anaconda	270,000	270,000
Chrome, American Metal	240,000	240,000
Great Falls, Anaconda	165,000	165,000
Maurer, A. S. & R.	138,000	140,000
Tacoma, A. S. & R.	114,000	130,000
El Paso, Nichols	.....	100,000
Inspiration, Inspiration	25,000	36,000
Ajo, Calumet & Arizona	10,000	(a) 18,000
		1,781,000
Furnace Refineries		
Hubbell, Cal. & Hecla	108,000	(b) 150,000
Houghton, Michigan Smelting	38,000	(b) 85,000
Hancock, Quincy	15,000	(b) 30,000
Hayden, Phelps Dodge	10,000	10,000
		275,000
Total United States		2,056,000
South America		
Chuquicamata, Chile	200,000	200,000
Caletones, Braden	120,000	120,000
Potrerillos, Andes	45,000	45,000
		365,000
Canada		
Copper Cliff, Ont. Ref.	.....	120,000
Montreal East, Can. Cop.	.....	75,000
Trail, Consolidated	25,000	(c)
		195,000
Total, North and South America		2,616,000

(a) At present closed down and not included in total, as but little leaching ore remains. (b) Data from American Bureau of Metal Statistics. (c) Reported being dismantled.

Construction of a 200,000-ton copper refinery at Liverpool is being considered by British Metal Corporation, to handle blister from Northern Rhodesia, but the plans are in abeyance as a result of the present depression in the copper industry. Bwana M'Kubwa, so far the only copper producer in Rhodesia, has not refined its copper electrolytically. Production of 200,000 tons of copper annually in England would leave a surplus, over English requirements, of 40,000 to 50,000 tons for distribution in Europe. At present, only two small refineries are being operated in England, and the production therefrom is negligible. British Metal, through its affiliated company, Amalgamated Metal, is in close contact with the Metallgesellschaft, the leading German metal producer, and the Société Générale des Minerais, of Belgium.

The German copper refinery output for 1930 was 126,653 metric tons. Details of plants are not available.

A new Russian electrolytic refinery at Sverdlovsk, with an annual capacity of 100,000 metric tons, is expected to be ready in 1932, construction having started last year. This plant's production is not expected to equal Soviet requirements, but the future, both as to plant construction and requirements, is difficult to predict. Japanese refinery capacity is given by the author in the 1929 volume of "Mineral Industry" as follows:

Annual Capacity of Japanese Copper Refineries

Site	Tons	Owned by
Hitachi	45,000	Kuhara
Nikko	30,000	Furukawa
Amagasaki	7,500	Furukawa
Osaka	14,000	Mitsubishi
Besshi	9,500	Sumitomo
Kosaka	9,000	Fujita
Moji	8,500	Nippon M. & M.
Denkibundo	6,000	Denkibundo
	129,500	

A summary of these refining capacities, including the new Liverpool plant under consideration, but excluding the refined copper produced electrolytically from leaching plants in Rhodesia, is as follows:

World's Refining Capacity

	Tons of 2,000 Pounds
North and South America	2,616,000
Germany	160,000
Belgium	121,000
England	200,000
Russia	110,000
Japan	130,000
	3,337,000

This total of 3,337,000 tons of world's refining capacity, present and planned, is obviously an underestimate owing to the omissions noted, yet it is a staggering total. I estimate that the world requirement of copper in 1940, assuming a 6 per cent annual increase and assuming that 1940 is not the nadir of the next copper cycle, will be 3,815,000 tons. Taking into consideration the Rhodesian electrolytic from leaching, present refining capacity, with an overload of less than 10 per cent, is apparently ample for the next decade.

Bucket Excavator With Crane Conveyor

Strips Simultaneously on Two Levels

Dipl. Ing. Karl Baldauf

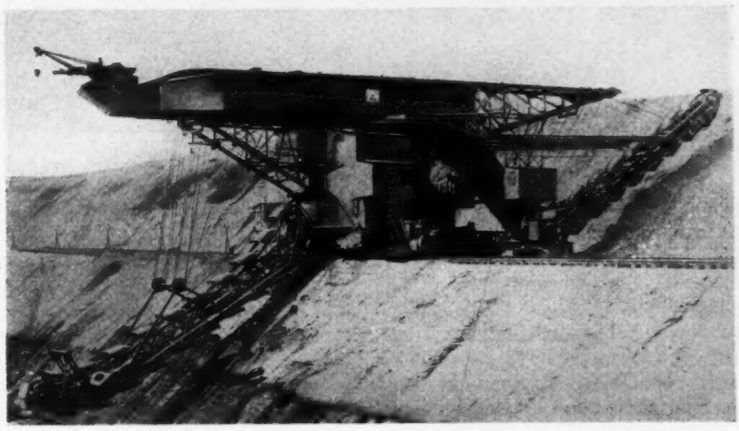


Fig. 1—Compound excavator, discharging into cars

THE excavating and dredging mechanism of a bucket-chain excavator employed for stripping overburden may include several features that warrant, perhaps, a more detailed description than that which was presented in a recent article in this publication.[1] The lower-level bucket ladder of the Buckau excavator, to be described, is for the first time used in combination with a rotating upper-level bucket ladder, as shown in Fig. 1. As the unit is a combination of two separate excavators, it has been designated a "compound excavator." The bucket ladder used for the lower level is attached to the main structure, in the same manner as an ordinary deep excavator; the upper-level ladder is designed to rotate around the excavator cab. This arrangement permits independent operation of the two bucket ladders. Operation of the excavator is generally guided first by the lower-level ladder, and then by raising, lowering, or rotating the upper-level ladder to conform to the terrain. The excavator may discharge into cars (for rail transport) as shown in Fig. 1, or it may work with a crane conveyor, as illustrated in Fig. 2.

Considering weight and output, the installation is regarded as the largest bucket chain excavator in the world. A few of the more important technical details are as follows:

Over-all height of the excavator, measured from top of rails, 44½ ft.

Rotating angle for the upper-level ladder, measured on either side of the normal plane, 90 deg.

Depth of excavation, with bucket at an angle of 40 deg. (leveling end horizontal), 39½ ft.

Height of excavation, with bucket at an angle of 40 deg. (leveling end horizontal), 36 ft.

Capacity of buckets on each ladder, 1 cu.yd.

Number of buckets on each ladder emptied per minute, 24.

Approximate normal output per working hour, 2,100 cu.yd.

All parts of the driving machinery, which are easily accessible and open to inspection, are subdivided to supply power to the upper- and lower-level excavator mechanism, to the rotating mechanism, and to the main drive of the excavator, which runs on two 3-ft. gage double-rail tracks, 28 ft. apart. On the lower-level side the excavator is supported on two eight-axle trucks; on the upper-level side, on two four-axle trucks, linked, to give even load distribution, so that a statically sound three-point support is assured. As the different trucks are interconnected, the weight of the excavator carried by the trucks is distributed evenly over 48 traversing wheels.

The following are features of the excavator equipment: Compressed air, produced in an automatic electrically driven plant, is used for operating the coupling mechanism controlling both lower-level and upper-level excavator units and for working the discharge flaps, necessary when the excavator is

Fig. 2—Crane conveyor receiving excavator discharge

[1] "New Method of Mining Overburden in Germany," *Engineering and Mining Journal*, March 28, 1931, p. 282.

Fig. 3—Leveling end of lower-level excavator, showing 1-cu.yd. buckets

discharging into cars. A system of pipes for cleaning purposes and for blowing out the electric motors and switches is distributed to the different parts of the excavator.

Mechanically operated, high-pressure, forced-feed lubricators have been chosen to insure reliable lubrication. Most of the working parts running at high speed have also been equipped with automatic lubricators.

A system of telephones has been installed in all cabs, to permit communication among the various operators on the excavator and on the crane conveyor. An extensive signal installation, supplied by A.E.G., serves to transmit visual signals.

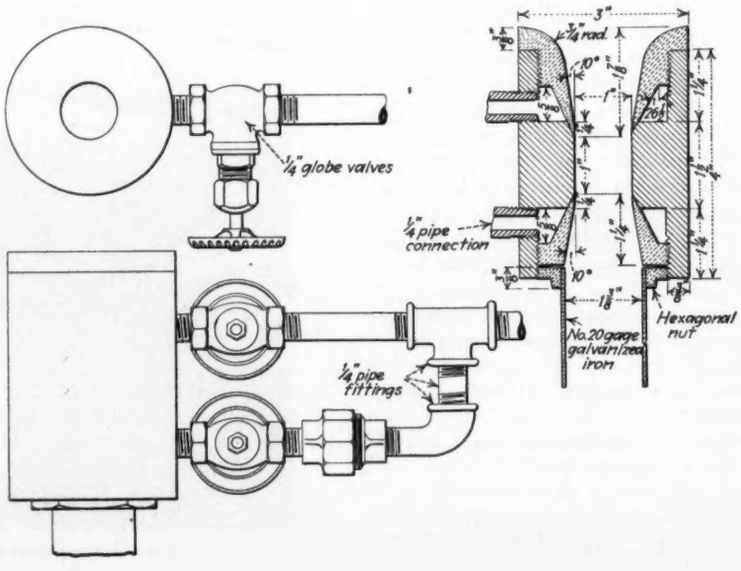
The electric equipment consists of eighteen motors, including three motors for the traversing drive; two motors for the buckets; three motors for the winch; and one motor for the rotating mechanism. Nine additional motors are used for operating the compressors, the conveyors, and the leveling device, shown in Fig. 3. The crane used for rotating the excavator, running along the top, is equipped with an individual motor. The total capacity of these motors is about 750 kw., or, in round figures, 1,000 hp., and the working tension is 5,000 volts. Transformers inside the excavator supply current at from 220 to 380 volts, to operate the different small motors and for lighting purposes.

The Buckau excavator, designed and built by Maschinenfabrik Buckau R. Wolf A.G., of Magdeburg, was first used in the spring of 1929, primarily for rail haulage. Later in the year, haulage with crane conveyor was introduced. During this time the expectations in regard to performance have been fulfilled and its reliability has been fully established; even with the customary continuous operation on three shifts the estimated capacity is constantly maintained.

■ ■ ■

Efficient Air Injector for Raise Ventilation

IN DRIVING raises of considerable height, ventilation is important because it materially influences the efficiency of the operator, drilling, and costs in general. Well-ventilated raising operations mean faster drilling speed, rapid removal of smoke and gases after blasting, and lower costs. This can be accomplished in two distinct ways: first, by the installation of small blowers and canvas tubes, which is costly from an operating standpoint because of the expense involved for power and maintenance; and, second, by the method recently adopted at the Pilares mine of the Moctezuma Copper Company, Pilares, Sonora, Mexico, of supplying air through a diamond-drill hole that connects the back of the raise with the upper level. Although this practice is by no means a new one, the air injector provided at the top of the drill hole to convert high- into low-pressure air, in addition to absorbing a considerable amount of atmospheric air, as illustrated in the accompanying self-explanatory sketch, is of interest. The cylindrical injector, containing two ¼-in. pipe connections equipped with corresponding globe valves and changeable cone ends, delivers 60 cu.ft. of low-pressure air to the back of the raise from every 20 cu.ft. of compressed air entering the conical interior of the injector through the upper pipe connection—a quantity more than sufficient to improve working conditions in the raise. Reversal of the flow of the compressed air by closing the upper globe valve and allowing the compressed air to enter the interior of the injector through the lower pipe connection creates a suction, and the smoke and gases present in the back of the raise after blasting are thus enhausted within a few minutes.



Alaska Juneau Milling System

FROM data and a flow sheet supplied by Mr. P. R. Bradley, on the operation of the Alaska Juneau mill, the accompanying drawing has been prepared, depicting quantity flows as bands of proportional width. The four important steps are (1) coarse crushing and sorting; (2) fine grinding; (3) concentration; and (4) re-treatment of the rougher concentrates. Coarse crushing is by three 36x48-in. Buchanan crushers; secondary crushing by three Allis-Chalmers 9-K gyratories. Interesting ratios can be prepared from the data based on 10,000 tons per day.

Primary crusher receiving area is 36 sq.ft., and the rate of receiving ore is 11.5 tons per square foot per hour. The grizzlies receiving the crusher product have an area of 60 sq.ft., with 4-in. spaces between the bars. As all the tonnage passes over these grizzlies, the tons per hour per square foot is almost equal to 7. The material passing through the grizzlies is somewhat over 3.5 tons per square foot (grizzly surface) per hour, and the oversize discharge somewhat less.

The primary sorting belts, which receive 4,100 tons, are three in number, 42 in. by 22 ft., and having a movement of 100 ft. per minute. The "flow" is 2.85 tons per minute, and the belt area receiving this is 1,050 ft. per minute; or each belt in exposing 350 sq.ft. per minute of travel receives about 0.95 ton. Of this only 19.5 per cent, or 0.19 ton per minute per belt, is removed by hand, the remainder being discharged at the end of the belt as waste rock.

The three secondary gyratories receive 800 tons, or at the rate of 11.1 tons per hour per gyratory. The grizzly area receiving this discharge below each crusher is 21 sq.ft. (7x3 ft., 1½-in. spacing). This is at a rate of 0.53 ton per hour per square foot of grizzly surface. The material passing the grizzly bars is 0.066 ton per square foot per hour and oversize discharge 0.464 ton per square foot per hour.

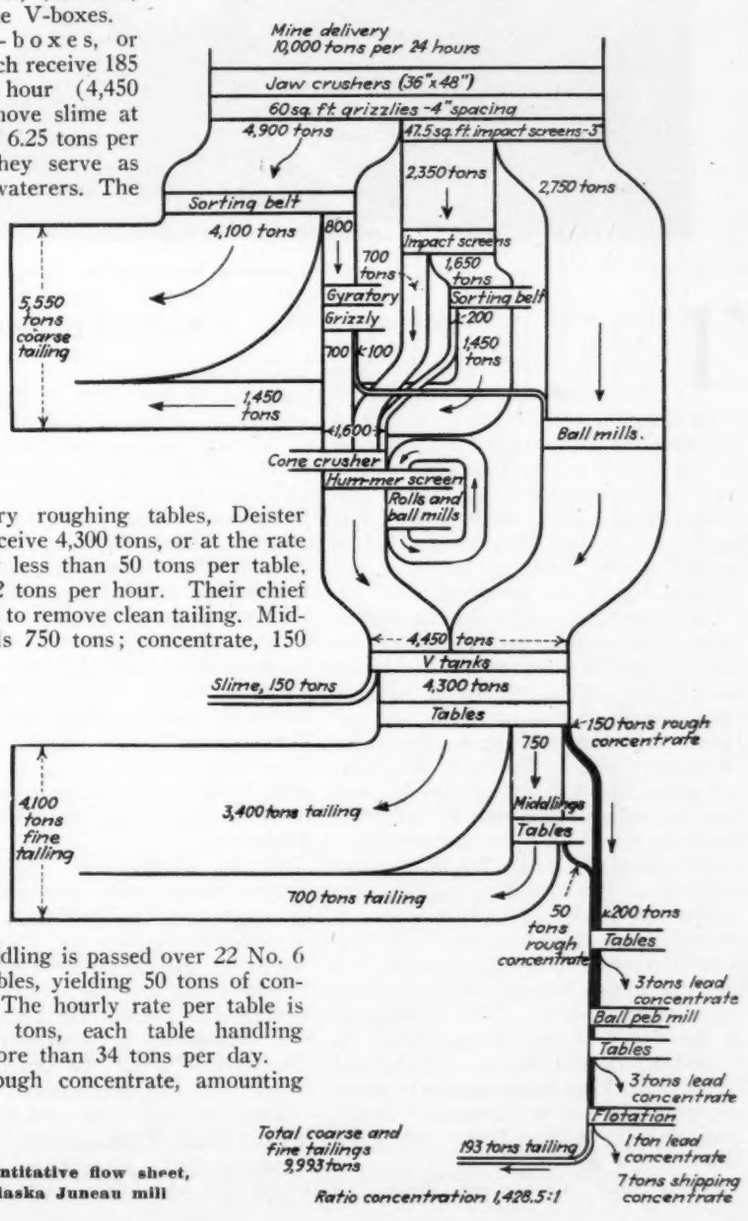
Undersize from the primary crusher grizzlies totals 5,100 tons per day. This is handled upon three Niagara screens, each 2.5x5 ft. with 3-in. square openings, at the approximate rate of 5.6 tons per square foot per hour, of which the material put through is at the rate of 3 tons per square foot per hour. Oversize discharge is 2.6 tons per square foot per hour. The secondary screens receiving the oversize from the first battery handle 2,350 tons, of which 700 tons is oversize and 1,650 tons undersize. This is at the rate of 2.6 tons per square foot per hour. Total material handled amounts to 0.77 ton per hour per square foot and oversize is 1.8 tons per square foot per hour.

Secondary sorting belts receive 1,650 tons. Two belts are employed, 42 in. by 8 ft., moving 150 ft. per minute. The total removed is 200 tons, the remaining 1,450 tons being discharged as coarse tailing. Belt surface per minute is 525 ft. and each belt receives a flow of 0.57 ton per minute. The picking rate per belt is 0.14 ton per minute, or 8.3 tons per hour.

Feed to the cone crusher totals 1,600 tons, or 66.6 tons per hour. Cone crusher product goes to Hum-mer screens, which give a finished undersize of 7 mesh. Oversize products go to rolls and to ball mills, the respective products being returned to the Hum-mer screens. Undersize from the primary screens plus the undersize from the gyratory grizzlies, 2,850 tons, is ground in eleven 8x6-ft. Marcy ball mills at the rate of about 260 tons per day per mill. Finished product of ball mills and grinding is to a maximum of 7 mesh. The total product, 4,450 tons, goes to the V-boxes.

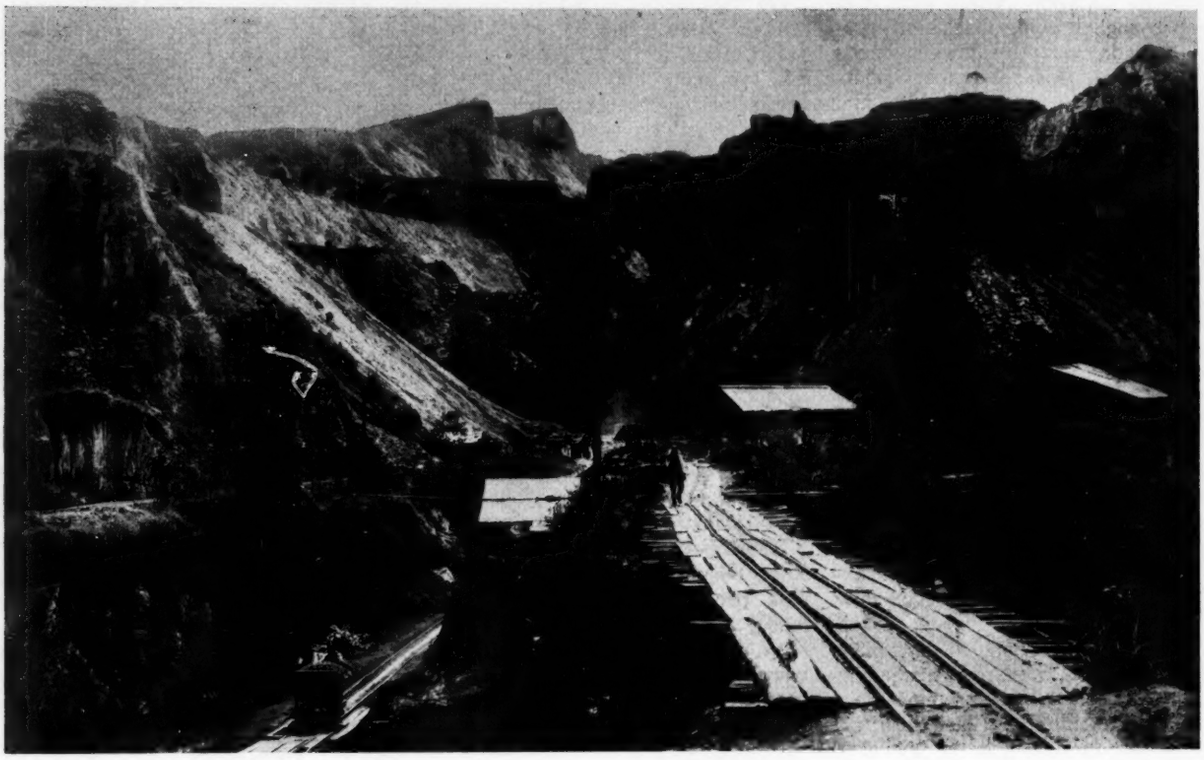
The V-boxes, or tanks, which receive 185 tons per hour (4,450 tons), remove slime at the rate of 6.25 tons per hour. They serve as partial dewaterers. The 88 primary roughing tables, Deister Plat-O, receive 4,300 tons, or at the rate of slightly less than 50 tons per table, or about 2 tons per hour. Their chief function is to remove clean tailing. Middling totals 750 tons; concentrate, 150 tons. Middling is passed over 22 No. 6 Wilfley tables, yielding 50 tons of concentrate. The hourly rate per table is about 1.5 tons, each table handling slightly more than 34 tons per day.

Total rough concentrate, amounting to 200 tons, is first tabled, separating out 3 tons of lead concentrate. The remaining 197 tons is ground in two 5x5-ft. Allis-Chalmers pebble mills and the product tabled, giving 3 tons more of lead concentrate. Tailing from this operation is passed through two 18-in. sub-A. Type M.S. machines, and another ton of lead concentrate obtained, the flotation tailing going to waste. The six tons of lead concentrate is subjected to a further tabling, which separates a high-grade gold concentrate, a shipping lead concentrate, and a small amount of tailing, which is returned to the cleaner circuit. The gold concentrate is amalgamated in a barrel and the gold recovered in the usual way. The seven tons of galena concentrate represent a ratio of 1,428.5:1. Gold represents 1 part:618,000 parts of ore. To obtain one ounce of gold about 21.16 tons of ore is handled. The value of the gold product per day has been estimated to be about $10,000.



Quantitative flow sheet, Alaska Juneau mill

Manganese in Brazil



An open pit at Morro da Mina, Minas Geraes

Emilio Teixeira

THE State of Minas Geraes, Brazil, possesses a large reserve of rich iron ore, but its importance as a producer of manganese, for 30 years, is not so well known. Its deposits and reserves are the largest in the Americas. Other parts of Brazil, such as Bahia and Matto Grosso, have deposits also, but they are far less important. This is because of the location, grade of the ore, and capacity of the mines.

The manganese deposits in Minas Geraes are in the central part of the state, a section crossed by the trunk line of the Central of Brazil railroad on its way northward from Rio de Janeiro. Distances of the districts from the seaport vary. The more important and producing districts are Queluz and Burnier, which are about 462 and 510 km. from Rio de Janeiro, respectively.

According to Orville Derby, the ore is found in two series of rocks. One consists of limestone and itabirite (a quartzite containing micaceous hematite) and the other of an eruptive garnet. To the first group belong the deposits of the Burnier district. They are found in the rocks of the Minas Series in bedded layers of itabirites, schists, and limestones. They occur especially along the branch line of the Central of Brazil from Burnier to Ouro Preto. They are Huronian in age.

Deposits of the second group, of Laurentian age, are residual, being derived by decomposition and leaching of one or more type of rocks. Those in the Queluz district are of this type and constitute the principal source of production. The ore is spongy and compact. In the Burnier type, however, the ore is powdered and soft and has hygroscopic properties.

The topography of this region is rough and mountainous. The altitudes of the mines and deposits vary from 2,700 to about 3,800 ft. Mineralized areas are found at elevations of 4,300 ft. Itabira peak, 5,700 ft. high, shadows the Esperança iron works, and Itacolomy peak, 5,930 ft., dominates the old mining town of Ouro Preto and the Passagem gold mine.

In the districts of central Minas Geraes the ores are mainly manganite, pyrolusite, and psilomelane. Although in some mines they are found mixed, manganite and psilomelane predominate in others. In the Morro da Mina mine, near Queluz, psilomelane is the principal ore. Manganite is found more often in the deposits along the branch line to Ouro Preto and Marianna.

The ores vary in grade, but are usually high in manganese. In some mines, a large percentage of iron is found, yet the silica and phosphorus contents are low. The grade of the exportable ore at Morro da Mina averages between 48 and 50 per cent manganese. No special treatment is given to improve its grade and for this reason a better grade can be mined if desired. At the Wigg mines, near Burnier, the average runs higher than 53 per cent. A special grade of ore mined there runs as high as 59 per cent. Silica, iron and phosphorus are very low. At Agua Preta, Sao Gonçalo, and Bicho the ore is of lower grade, as compared with that found at Morro da Mina.

Ouro Preto, Marianna, Serra da Moeda, and other districts have ores of varied quality, but usually high in iron. This is so in mines like Nazareth and Coqueiros, which have been closed since 1919.

The state has several mineralized areas. Mining, however, is mainly at Queluz and Burnier. Ouro Preto, Marianna, Entre Rios, Serrá da Moeda, Morro Grande, and Sabara have deposits also. Development work has been done at Nazareth and Coqueiros, near São João del Rey, and at Diamantina, in the north. The most productive districts are Queluz and Burnier, from which comes the bulk of the output. In other parts in the state manganese outcrops are found. I have seen several of these, one with high-grade mineral, but distance to the nearest railroad was too long for economic mining.

In the Queluz district, the principal mines are Morro da Mina, Agua Preta, S. Gonçalo, and the Santa Mathilde mines. Many others, operating up to 1919, are now idle. All are situated along the Central of Brazil railroad. Export is made through Lafayette, the railroad station that serves Queluz. When the railroad was built, the town was a short distance away. With subsequent development, Queluz and Lafayette became one town. The name of the station, however, continues the same.

In the Burnier district are the Wigg mines, Rodeio, and several small properties not under development. The same is true regarding Ouro Preto and Marianna. Among the best producing properties in Minas is the Morro da Mina, on the eastern side of the Central of Brazil railroad at 3,650 ft. elevation. The connection to the main line is made by a short branch line about 4 km. long. The property has been known for years. Its unusual outcrops, the black and metallic aspect of the mass, attracted attention. The morro, or hill, was sold for the ridiculous price of twenty contos, or about $6,000.

A company was then organized. The outcrops were fire worked by open-cut mining on several levels of the hill. When I first visited the mine, in 1919, extensive exploration was in progress under Dr. Joaquim Lustosa, chief engineer. A shaft over 200 ft. deep was sunk in ore, and several galleries were driven. The result was the discovery and blocking of an unusually large orebody of high-grade ore, perhaps the largest known anywhere. The size of the deposit and its possibilities attracted American business men, who entered into negotiations for the property. The purchase was made in 1920. The Companhia Meridional, a subsidiary of the United States Steel Corporation, paid $4,000,000 for the property.

Morro da Mina is the largest producer in the state. Its location, facilities for mining and transportation, the richness and amount of ore in sight, make it an unusual property. The amount of ore disclosed by prospecting is estimated at 10,000,000 tons. During the War, the production of the mine was increased considerably, and in 1917 reached an annual figure of 396,000 tons. The Armistice, and the subsequent drop in price and consumption of manganese ore, caused a serious decline in production. Up to 1920, about 1,740,000 tons of ore was extracted at Morra da Mina. With present equipment and facilities, an average of 1,000 tons can be mined daily. The ore, mainly psilomelane, is compact. That which is exportable analyses: Mn, 48 to 51 per cent; P, 0.10; Fe, 5 to 8; H, 6; Si, 3 to 4 per cent. The ore is loaded at the mine, after being weighed, and taken, over the Central Railroad of Brazil, to the stockpiles at Rio de Janeiro, or directly to the cargo boats. Morro da Mina is ideally located. No other property in the state is so well situated with reference to mining, markets, and future development. Cost of production is low, because of these natural advantages.

The Wigg mines are near the Usina station on the branch line at Ouro Preto. The distance to Burnier is 3 km. Mining is underground, and the ores are rich, soft and sometimes powdered, hydroscopic, and low in silica and phosphorus. A special grade has a high purity, and commands special prices. The mines are on each side of the railroad. The ore is transferred to the broad-gage line at Burnier or Lafayette. It has the following characteristic analysis: Mn, 53 per cent; Si, 1.5; H, 10; Fe, 3.5; P, 0.03 per cent. Production is small, but the ore brings high prices.

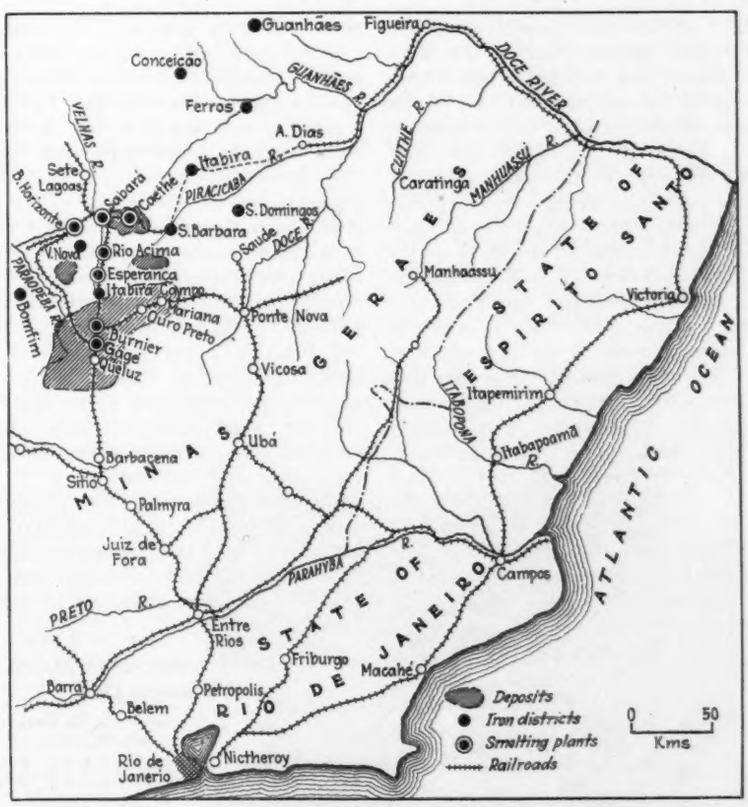
Mines explored by A. Thun & Company comprise S. Gonçalo, Agua Preta, and Cocuruto. S. Gonçalo is situated in the Queluz district, on the west side of the Central of Brazil railroad. The ore has to be screened and washed, to raise the grade. It is of the Morra da Mina type, but inferior in quality. The average analysis is Mn, 46 to 48 per cent; Fe, 5; Si, 6 per cent. Production is 25,000 to 30,000 tons per year. The mine has outputted a total of about 1,500,000 tons. Costs are high.

Mining methods at Agua Preta, near Morro da Mina, are about the same as at S. Gonçalo, and the ore is of the same type. The mine can produce about 45,000 tons a year. Cocuruto, Casa de Pedra, and Botafoga are other properties of the same company, all more or less idle. Cocuruto was worked formerly by a Belgian company. Casa de Pedras lies near Congonhas, a few kilometers from the Central of Brazil. It is said to be a property with large reserves of manganese and iron ores. Botafoga is near Tripuhy, on the branch line to Ouro Preto. The ore is high in iron. High costs of mining and of transportation are said to be the reasons for lack of activity.

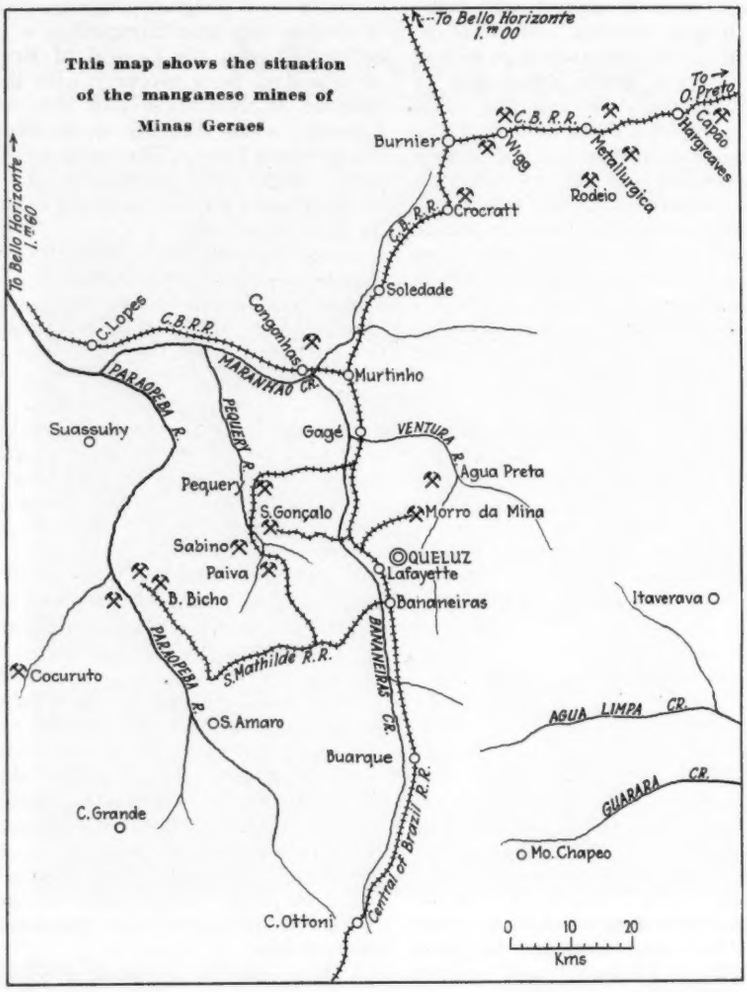
Santa Mathilde lies to the west of the Central railroad. This company operated several mines at the time of the World War. Activities have decreased, in consequence of market conditions and local difficulties. The mines are Pequery, Sabino, Paiva, Sabugo, and Buraco do Bicho. The company built a 24-km. meter line to the last place and a branch line 0.6 km. long to Sabino and Pequery. Production has been relatively small. The ore runs over 45 per cent.

Along the branch line to Ouro Preto and Marianna many small mines and deposits are found. Near the station of Metallurgica is the Rodeio mine. It lies in a valley, and the ore is mined underground. A shaft through the ore formation makes the connection with the lower workings. The ground is loose and unsafe, caving usually taking place. The ore is subjected to washing. Rodeio has fair equipment, and possesses its own electric power plant. It is connected with Metallurgica by a rope cable line, 6 km. long. Other mines are near the station and are of minor importance and now idle.

A large number of small properties



The manganese mining district (hatched area) of Minas Geraes in its relation to the seaboard



may be found in other districts of Minas, all of which operated during the War. High prices, and relaxed requirements as to grade of ore, caused one of the greatest mining rushes since colonial times. From 1915 to 1919, the manganese district of the state saw its golden days. Everywhere in the mountains, a hole, a trench, a drift, a small shaft, were the signs of the steps of the prospector. Near the branch line to Ouro Preto, especially, the rush was evident. I was sent, once, to examine some mines. Some of the ore was very poor. To me it looked more like iron than manganese. Inquiring of the miners how they were mining such a grade, the reply came, simple but expressive: "The boss told us that all that is black is ore." The result was that about 200 tons was piled at the switch, but did not yield 20 per cent after careful picking.

Although this enthusiasm for winning manganese was not a financial success to many miners, the result was a general prospecting, the advantage of which is not to be overlooked. Everywhere the search was made. In some cases, the disclosure of workable deposits resulted; and in others, data were gathered for future work.

The Capão do Lana property, famous for its former topaz mining, was expected to prove unusual. The prospecting there was under my personal direction. Intensive work was done to disclose a dependable deposit. The result, however, was negative, but interesting data were gathered regarding the ore and future possibilities. At Alto da Figueira, the northern part of the property, at an elevation of nearly 4,400 ft., a small deposit, composed mainly of manganite veins, was prospected. In one of the galleries a careful sample of manganite was taken and analyzed, giving Mn, 59.72 per cent; Fe, 0.14 per cent. Of course this was the best sample one could get from that vein. On the other hand, a sample of the working face showed Mn, 41.88 per cent; Fe, 11.97 per cent.

In another part of the property, a sample taken from the middle of a boulder about 3 ft. in diameter analyzed Mn, 52.03 per cent; Fe, 0.71 per cent. In the valley, in a deposit of entirely different structure and formation, a picked sample gave Mn, 58.45 per cent; Fe, 1.76 per cent. A sample of the working face of the same gallery ran Mn, 38.24 per cent; Fe, 14.45 per cent. These samples are given to show the characteristics of the majority of the deposits in this district. At Ouro Preto and Marianna are several mines, now closed. The same is true of the other districts not described here.

Table I—Analyses of Minas Manganese Ores

	Per Cent				
	Mn	Fe	Si	P	H
Morro da Mina	51.0	5.0	3.0	0.10	6.0
Morro da Mina, common	48.0	5.0	4.0	0.10	6.0
Agua Preta and S. Gonçalo, washed	48.0	5.0	6.0	....	....
Wigg mines, common	53.0	2.5	2.0	0.04	10.0
Wigg mines, rich	58.0	2.0	1.5	0.03	....

Table II—Production of Minas Geraes Mines

in Metric Tons

1897	18,000	1921	385,000
1900	139,000	1922	284,000
1905	154,000	1923	224,000
1910	230,000	1923	179,000
1915	310,000	1924	307,000
1917	396,000	1926	273,000
1918	366,500	1927	282,000
1919	321,500	1928	344,000
1920	276,000	1929	295,000

With the Armistice in 1918, manganese suffered a sudden lowering in price and demand. There was depression in the mining camps, as well as in business. Only mines capable of mining good ore at a low enough price could continue in the market. The result was one of natural selection: only the large properties survived.

Transportation of manganese ore to Rio de Janeiro, the nearest seaport, is a privilege of the Central of Brazil railroad. All the mines now active have their connections with the railroad. The handling of ore seems to be satisfactory. The Morro da Mina is in a favorable position. It has the broad-gage line at its door, and possesses facilities for quick loading.

Production of manganese in Minas Geraes reached its maximum during the War. Since then, the output has been irregular, the figures showing a few years with small tonnage and a few others with high. Statistics show that mines now active are capable of maintaining output. The irregular production indicates the control exercised by Morro da Mina, whose policy in mining, and especially in shipment to Rio de Janeiro, is governed by demands in the United States.

Cia. Meridional produces about three times as much as all the others combined. Morra da Mina is in the first rank. São Gonçalo and Agua Preta are good producers and can increase tonnage. Santa Mathilde's output is not large, inasmuch as many of the mines have suspended operations.

Costs of mining manganese in Minas Geraes show variations from mine to mine. Morro da Mina ranks first, the favorable conditions at this mine helping to keep down expenses. About 1925, a ton of ore was being mined at between 5 and 6 milreis, or from 59 to 70c. With the addition of other expenses, including transportation, the ore is delivered to the docks at Rio de Janeiro at a cost not below 39 milreis, or $4.59.

A. Thun & Company and Santa Mathilde costs are much higher—not less than $6.80 at Rio de Janeiro. The first-mentioned company has one of the islands in the bay at Rio, to which the ore is transported in small boats. Freight to Europe is about 48 milreis, and to the United States 44 milreis, per ton.

Penalties to which the ore is subject depend on contractual clauses. The following example, however, is given: 36c. per ton per unit below 48 per cent Mn; 18c. above 5 per cent Fe; 18c. above 3.5 per cent Si; 24c. per 0.01 per cent above 0.12 per cent P.

The State of Minas taxes the exportation of manganese. The taxes have been changed several times to help the industry, and also according to market conditions. In 1929, the exportation from the mines in the state was 295,000 tons, and the value for the purpose of tax payment was about $4.15 per ton. The tax corresponds to about 10 per cent, or 41c., per ton. The state maintains an inspection department, at Rio de Janeiro, for the collection of manganese taxes.

The principal market for Brazilian manganese is the United States. Europe also is a buyer. Exports have varied. The entire output of Morro da Mina goes to Baltimore and Philadelphia. Other exporters ship to Havre, Marseilles, Dunquerque, and Hamburg.

Development of a metallurgical industry on a large scale must come sooner or later in the State of Minas. The large reserves of high-grade iron ore and the great need for finished metal make this clear. The manganese reserves of the state are a further incentive to the establishing of a steel industry. Brazilian reserves of manganese should be studied more carefully and should be better controlled. I do not know whether or not the government has any plan regarding this. One fact, however, must be faced: the free exportation of the best ores. Reserves are large. Mining and exportation cannot be discontinued, because no other procedure is possible at present. Brazil must know exactly what it has, and what should be done. For this reason, plans should be made, based on dependable data. The problem is intimately related to the development of metallurgy in Brazil.

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Technical Practice at Tepezala Mines, Mexico

UNION Copper was formed in 1929 by Henry Wyman to operate the Tepezala mines, at Cobre, Aguascalientes, Mexico, owned by the Guggenheim interests. An 11-mile railroad, which connects the mining camp with the National of Mexico line at Rincon de Romas, was included in the lease, covering a total period of 25 years.

The Tepezala copper mines have been worked since the time of Cortez, Spanish conqueror of Mexico, and not fewer than seventeen shafts have been put down on different parts of the properties. The most recent attempt to operate them, previous to acquisition by Union Copper, was by Aguascalientes Metal, which also operated under lease from Guggenheim Smelting. Lack of milling facilities was said to have been the chief reason for suspension early in 1927.

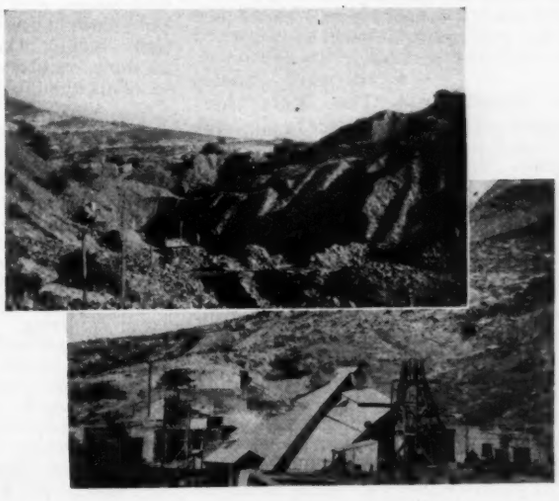
Construction of a 300-ton concentrator was started immediately after acquisition of the lease and it was put in operation in February, 1930. An additional 300-ton unit was put in operation in July of that year, but because of slight trouble encountered with one of the grinding units, capacity operation was not reached until the end of October. At present, the company is employing about 400 men in the mine, mill, and railroad. Production of 600 metric tons of ore daily is obtained from old mine fills and from a low-grade surface dump as well as from new stopes. The grade of mine ore is about 3.5 per cent copper, mine fills assay about 2 per cent copper, and dump material contains 1 per cent copper. Average grade of mill heads is 1.3 per cent. A concentrate averaging about 22 per cent copper is produced.

Development of the mine has been conducted largely through the San Pedro shaft. This is a two-compartment, steel-lined unit, bottomed at 600 ft. It is equipped with a 125-hp. Wellman-Seaver-Morgan two-drum electric hoist. The compressor unit is 440-hp. Ingersoll-Rand synchronous-motor compressor, and drilling equipment includes Ingersoll-Rand and Chicago Pneumatic rock drills. A Cameron pump, handling about 250 g.p.m., keeps the workings unwatered and supplies the mill with all its water requirements. Electric haulage has not yet been installed underground, but equipment has been purchased and will soon be put into use.

Recently the company reopened the old Tiro Azul shaft, 150 ft. deep, and it has developed a high-grade orebody on the bottom level. A headframe has been erected and a 50-hp. Wellman-Seaver-Morgan electric hoist has been installed to facilitate development work, which is now being pushed on a three-shift basis. In addition, the company is driving a new 2,600-ft. development tunnel, which has its portal near the mill and the San Pedro shaft. This tunnel will be used to mine a large body of low-grade ore indicated by previous work to exist above the mill level. Dump material is handled by a three-drum Sullivan slusher and is hauled to the mill over a 24-in. gage track. A 2½-ton Whitcomb gasoline locomotive is in use.

At the mill, the equipment includes a 20x24-in. Allis-Chalmers jaw crusher; a 4-ft. Symons cone crusher; two No. 86 Marcy ball mills (8x6 ft.); two 6x21-ft. Dorr drag classifiers; four 20-ft. McIntosh flotation machines; two 10-ft. McIntosh flotation machines, acting as cleaners; a Dorr thickener; and a three-leaf, 4-ft. American filter. In addition to the copper content of about 22 per cent, concentrate averages about 1,300 grams of silver to the ton.

Concentrate is shipped to the San Luis Potosi smelter of American Smelting & Refining. The company's rolling stock on the standard-gage line includes a 9-ton Whitcomb gasoline locomotive and fourteen box cars. Power for the operations is obtained from the plant of Minerva Mining, at San Gil, Aguascalientes. Union Copper built a 3½-mile transmission line to connect with the Minerva main line. At present about 650 to 700 kw. is required for operating purposes, but when electric transportation is installed underground a larger amount will be needed.



The Providencia tailing dump, which Union Copper is retreating at present, is shown in the upper picture. The concentrator and mine headframe are shown below. Operations are at Cobre, Aguascalientes, Mexico.

Digest of Current Technical Literature

Selected from abstracts of articles in the leading technical periodicals, prepared by Engineering Index Service, American Society of Mechanical Engineers, 29 West 39th St., New York, N. Y.

Geophysical Exploration: Australia—"Geophysical Prospecting Results in Tasmania and South Australia." *Chem. Eng. and Min. Rev.*, Vol. 23, No. 267, Dec. 5, 1930.

SUMMARY of work done under direction of Imperial Geophysical Experimental Survey.—E.I.S. New York.

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Lead Smelting — "Rationalization of Melting Lead Ore." N. C. Kyriacou. *Génie Civil*, Vol. 8, No. 8, Feb. 21, 1931.

REVIEW of theories, practical methods and equipment used in America and in Europe, with special reference to practice of French firms in Greece; details of Basset rotary furnace.—E.I.S. New York.

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Ore-Treatment Plants—"Small Concentrating Plants." C. Lehmann. *Revista Fianciera Salitre y Minas*, Vol. 5, Nos. 54 and 55, Nov. and Dec., 1930.

MECHANISM of flotation; influence of air; selective flotation; reagents. Factors of operating practice; feeding of reagents; flotation machines.—E.I.S. New York.

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Dredges: Suction—"Recent Dredge Designs." W. Thiele. *V.D.I. Zeit.*, Vol. 75, No. 8, Feb. 21, 1931.

FEATURES of most recent designs of suction dredges; detailed descriptions of "Dredge Manila" and "Dique de Cartagena," built by F. Schichau G.m.b.H. in Elbing.—E.I.S. New York.

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Air Separators—"Separator-Grinder for Pulverulent Materials." *Génie Civil*, Vol. 98, No. 1, Jan. 3, 1931.

MACHINE for air separating finely ground material from coarser matter during pulverizing; when pulverizing coal, fineness equivalent to 5,500 meshes per square centimeter can be obtained for hourly expenditure of 10 to 15 hp. per ton.—E.I.S., New York.

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Crushed Stone Plants: Central United States—"Study of a Group of Crushing Plants in the Central West." E. C. Harsh. *Rock Products*, Vol. 34, No. 6, March 14, 1931.

QUARRY pumping; water for washing stone; automatic pump control; cost of pumping; pipe sizes should be liberal; how much to pump for drainage; quality of water for boilers.—E.I.S. New York.

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Mine Ventilation — "The Kata-Thermometer as an Anemometer." T. Bedford and C. G. Warner. *Jl. Indus. Hygiene*, Vol. 13, No. 1, Jan. 1931.

OBSERVATIONS made in coal mines are reported in which smell and smoke were used to test air velocities, otherwise measured by dry and kata-thermometer.—E.I.S. New York.

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Mine Hoists: Headframes—"Substitution of a Colliery Headgear Under Working Conditions." V. A. G. Desgrand. *Instn. Engrs. Australia—Jl.*, Vol. 3, No. 1, Jan., 1931.

TIMBER headframe at No. 3 shaft, Burwood coal mine, replaced by steel structure after 37 years of service; design of headgear; fabrication; erection of new structure alongside old one; method of erecting new structure; method of moving over new structure; moving and demolition of old structure, during Christmas holidays.—E.I.S. New York.

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Gold Ore Treatment: Cyanidation—"Cyanidation of a Copper-Gold Ore." E. H. Smith. *Can. Chem. and Met.*, Vol. 15, No. 2, Feb., 1931.

FUNCTION of lime in cyanide process; operating data.—E.I.S. New York.

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Pulverized Coal Firing—"Latest Practice in Pulverized Fuel Firing." *S. African Engr.*, Vol. 21, No. 152, Dec., 1930.

INSTALLATION consists of two "combustion steam generators" operating at 350 lb. per sq.in. and 750 deg. F. final temperature, and rated at 60,000-80,000 lb. per hour at Derby Corporation station in England, are described.—E.I.S. New York.

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Locomotives: Mine—"Designs of Recent Narrow Gage Internal Combustion Locomotives." F. Riedig. *Montanistiche Rundschau*, Vol. 23, No. 4, Feb. 16, 1931.

CHARACTERISTICS and properties for use in mining, of crude oil and gasoline locomotives; tables specifying consumption, weight, and tractive power of various types.—E.I.S. New York.

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Zinc Ore Treatment: Flotation—"Investigation of Influence of Iron Content of Zinc Blende on Its Floatability." L. Kraeber. *Stahl und Eisen*, Vol. 51, No. 9, Feb. 26, 1931.

TESTS carried out on seven specimens of zinc ore with varying iron content; results show that influence of iron content is so slight that other properties and factors have far greater influence.—E.I.S. New York.

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Iron-Ore Treatment: Sintering—"Preparation of Raw Material in Roechling Iron and Steel Works in Voelklingen." A. Wagner. *Stahl und Eisen*, Vol. 51, No. 8, Feb. 19, 1931.

PREPARATION of mixtures in treatment of oölitic iron ore; ore-crushing and screening plant; conditions governing sintering of oölitic ore; blast-furnace dust and fine ore; results with Lurgi sintering apparatus and Dwight-Lloyd large-scale sintering plant finally installed; influence of ore crushing on blast-furnace efficiency; effect of ash content of coke.—E.I.S. New York.

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Gold-Ore Treatment—"The Absorption of Gold in Tube Mills." H. A. White. *Chem., Met. and Min. Soc., S. Africa—Jl.*, Vol. 31, No. 6, Dec., 1930.

IN FIRST tube mill operated on Rand, about 12 per cent of value treated was locked up in tubes during first two months; in amalgamation mills, 1,000 to 2,000 oz. has been recovered from single tube upon replacing worn-out lining; until close upon saturation, tube mill will pick up gold at fairly even rate, proportional to value of free gold in pulp entering it; monthly and cumulative gold absorption; tabular data on experiment conducted for 192 days; effect of varying water supply; low percentage of moisture increases rate of gold absorption.—E.I.S. New York.

Metallurgy: South Africa—"Metallurgy in South Africa." S. W. Smith. *Min. Mag.*, Vol. 43, Nos. 5 and 6, Nov. and Dec., 1930, and Vol. 44, No. 1, Jan., 1931.

ACCOUNT of observations of practice when traveling with Empire Congress; gold-ore treatment on Witwatersrand. Rand refinery; Rand Mines Laboratories; co-operative smelting works; iron and steel industry; Pretoria mint; platinum industry; tin in Transvaal; Northern Rhodesia electrolytic zinc plant; Bwana M'Kubwa copper ore treatment and smelting.—E.I.S. New York.

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Rock-Drill Steel: Failures—"Why Rock-Drill Steel Fails—What Can Be Done About It." O. A. Knight. *Coal Age*, Vol. 36, No. 1, Jan., 1931.

ONLY so-called plain carbon rock-drill steel is considered approximate composition of which is shown; steel of this composition has narrowest and lowest critical range of all plain carbon steels; for forging, this steel may be safely heated to 950 or 1,000 deg. C.; for hardening, it should not be heated above 850 deg. C.; steel should not be heated in oxidizing atmosphere; other important factors—E.I.S. New York.

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Tin Mines and Mining—"Mining Alluvial Tin With Dragline Excavators." S. A. Westrop. *Min. Mag.*, Vol. 44, No. 1, Jan. 1931.

OBJECT of article is to suggest practical method of layout for working small alluvial tin properties by mechanical means at low rate per cubic yard, as substitute for gravel pumping operations, especially for properties on which water power is not readily available; method is applicable to ground varying from 5 to 30 or more feet deep and either carrying tin throughout its depth, or with varying percentages of overburden which carry no mineralization, and with varying percentages of large stones.—E.I.S. New York.

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Gold Mines and Mining: Australia—"Progress in the Development of the Wiluna Mine." W. A. *Chem. Eng. and Min. Rev.*, Vol. 23, No. 268, Jan., 1931.

MINE 120 miles east of Meekatharra; reopened by syndicate in 1924 after years of idleness; main shaft 820 ft. deep; 110 ft. steel headframe; ore treatment will comprise concentrating by flotation of gold-bearing sulphides, to about 10 per cent of original ore; roasting flotation concentrate; cyaniding roasted calcine; equipment; power plant; locality plan of mine and surface plants.—E.I.S. New York.

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Mine Ventilation — "Psychrometric Tables with Special Reference to Deep Mining Ventilation." C. W. B. Jeppe. *Chem., Met. and Min. Soc. S. Africa—Jl.*, Vol. 31, Nos. 4 and 5, Oct. and Nov., 1930.

DISCUSSION of some formulas governing physics of air; compilation of tables to assist research and experimental work; various deductions from these formulas and tables; thesis approved for degree of Master of Science in University of Witwatersrand.—E.I.S. New York.

Geodetic Instruments — "Progress in Geodesy, Topography and Cartography During the Last Half Century." G. Perrier. *Génie Civil,* 50th Anniversary Number, 1930.

REVIEW of progress in design and construction of geodetic and surveying instruments, including precise theodolites, meridian circles, and geophysical instruments.—E.I.S. New York.

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Gages—"Gaging and Measuring Methods." *Instn. Production Engrs.—Proc.,* Vol. 9, No. 7, Jan., 1931.

HISTORY of measures; metric system; length standard of United States; ratio of yard to meter; standards in manufacturing; internal limit gages; measurement of screw threads; angular measurement; standard taper gages; gear measuring.—E.I.S. New York.

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Microscopes: Metallurgical—"A British Metallurgical Microscope." *Metallurgist,* Feb. 27, 1931.

INVERTED metallurgical microscope (No. 30) put on the market by R. and J. Beck, Ltd.; instrument is small type incorporating principles embodied in Beck-Hadfield model, but long optical bench is replaced by shorter and non-adjustable base.—E.I.S. New York.

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Mine Ventilation: Fans—"Electric Drive for Main Shaft Ventilation." K. Schade. *Elektrizitaet im Bergbau,* Vol. 5, No. 11, Nov. 15, 1931.

CALCULATION of driving power, classification of various types of regulating and non-regulating direct and indirect electric drives and their characteristic regulating equipment; equipment is illustrated; wiring diagrams are given.—E.I.S. New York.

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Miner's Lamps: Electric—"Design and Types of Portable Electric Miner's Safety Lamps in German Practice." E. Sauerbrey. *Elektrizitaet im Bergbau,* Vol. 6, No. 2, Feb. 16, 1931.

DEVELOPMENT; design and types of lead and alkali storage batteries; details of lamp construction; various types used; special types.—E.I.S. New York.

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Ore Treatment: Flotation—"Principles of Colloidal Ore Treatment." C. Goetz and A. Horovic. *Internationale Bergtechnik,* Vol. 24, No. 3, Feb. 15, 1931.

COLLOIDIZATION experiments with ore of Rammelsberg near Goslar are explained by tables and curves; best peptizator proved to be citric acid; colloidal balance was reached more quickly by whirling up through air blown in than by shaking; best results of colloidization shows that period of action from one-half to one hour is sufficient when normally working.—E.I.S. New York.

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Geophysical Exploration—"The Method of the Ground Resistivity Map and Its Practical Applications." C. and M. Schlumberger. *Can. Min. and Met. Bul.,* No. 226, Feb., 1931.

EXAMPLES are cited to show that maps of resistivities of earth are analogous to geological log where different areas are characterized by their electric resistance; method of electrical logs is not abstract science, but simple and direct geological process.—E.I.S. New York.

•

Mine Hoists: Design—"Nomography as Aid in Calculating Electric Mine Hoists. F. Wolf and H. Hochreuter. *Elektrizitaet im Bergbau,* Vol. 6, No. 2, Feb. 16, 1931.

MATHEMATICAL design analysis and nomographs for calculation of maximum allowable acceleration and retardation of Koepe sheave; starting and traveling speed curves; nomograph for determination of required traveling speed and of maximum speed.—E.I.S. New York.

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Cableways—"Aërial Wire Ropeways." J. W. White. *Quarry and Roadmaking.* Vol. 36, No. 409, March, 1931.

PRINCIPLES of design and construction; classification of systems.—E.I.S. New York.

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Fuller's Earth—"Fuller's Earth and Its Uses." H. L. Kauffman. *Mill and Factory Illustrated,* Vol. 8, No. 2, Feb., 1931.

OCCURRENCES, methods of mining and uses. —E.I.S. New York.

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Mines and Mining—Progress Realized in Mining Industry During 50 Years." C. Biver. *Génie Civil,* 50th Anniversary Number, 1930.

GENERAL review of progress in mining of metals, of coal, coal distillation, with special reference to French mining.—E.I.S. New York.

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Potash Mines and Mining: France—"The Potash Deposits of Alsace." V. Charrin. *Genie Civil,* Vol. 98, No. 10, March 7, 1931.

REVIEW of results of management of Upper Alsace potash mines by French; geology of basin; production statistics; mining and refining methods; production of potassium sulphate and bromine; marketing of potash products.—E.I.S. New York.

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Sieves: Standardization — "International Standardization of Sieves for Testing Purposes." *Mech. Eng.,* Vol. 53, No. 4, April, 1931.

ORGANIZATION of sectional committee to establish standard specifications for sieves for testing purposes, under auspices of American Standards Association, has been requested by American Society for Testing Materials; society proposes to offer, as working basis for consideration of A.S.A. technical committee, A.S.T.M. specifications on this subject developed in co-operation with Bureau of Standards in 1926.—E.I.S. New York.

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Mines and Mining: Gas Outbursts—"Pressure Reduction of Rock and of Gases by Mine Working." A Gaertner. *Glueckauf,* Vol. 67, Nos. 5 and 6, Jan. 31 and Feb. 7, 1931.

OCCURRENCE of outbursts in rocks of every nature with and without gas occurrence; occurrence of coal and gas outbursts; numerous examples are cited to show that outbursts with and without gas in metal, potash, and coal mines are due to sudden excess of limit pressure of strata which are more brittle and less rigid than surrounding rock. Bibliography.—E.I.S. New York.

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Gold Ore Treatment: Cyanidation—"Some Experiments on the Electro-Deposition of Gold From Alkaline Cyanide Solutions." E. T. Dunstan. *Chem. and Met. Min. Soc. S. Africa—Jl.,* Vol. 31, No. 4, Oct. 1930.

INVESTIGATION to determine whether improvement upon older methods of electrolytic precipitation of gold from cyanide solutions could be effected by use of rotary cathode; improvements aimed at were higher current efficiency, more complete precipitation, and increased rapidity of operation.—E.I.S. New York.

Gold Mines and Mining: India—"Ground Movements and Methods of Support in Deep Mining (The Kolar Gold Field)" P. J. Crowle. *Instn. Min. and Met.—Bul.,* No. 316, Jan., 1931.

RESULT of observations made during several years of close contact with mining operations; many of the investigations have been based on suggestions put forward by other authors; observations recorded refer particularly to Ooregum mine; geological data; general effects of pressure; classification of rock bursts; movements in large and small excavations; in fault zones; rock pressure; arching in caved rock; function of supports; costs.—E.I.S. New York.

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Metals Analysis, Spectrographic—"Spectroscopy as an Aid in Metallurgical Analysis." S. J. Lewis, *Metallurgist,* Feb. 27, 1931.

IN PRESENT study spectroscopy has been used merely to elaborate chemical analysis; iron, copper, and carbon were subjects of inquiry; arc-spectrum analysis was conducted by means of Hilger quartz spectrograph; examples illustrate value of spectrographic control in discovery of unsuspected elements, detection of various impurities not usually comprehended in chemical analysis, examination of quantitative precipitates for their purity, and in correction of gravimetric figures for proportion of impurities carried by precipitates—E.I.S.. New York.

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Asbestos Deposits: South Africa—"Asbestos in the Union of South Africa." A. L. Hall. *Union of S. Africa Dept. Mines and Industries—Geol. Survey,* No. 12, 1930.

VARIETIES and properties of asbestos minerals; deposits of asbestos in Cape Province; principal deposits of asbestos in Transvaal; chrysotile or white asbestos; amosite; crocidolite or "blue" asbestos; minor occurrences of asbestos in Transvaal, including North Swaziland; anthrophyllite; asbestos in Natal; tremolite; genetic problem; industrial aspects and use; statistics.—E.I.S. New York.

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Lead-Zinc Ore Treatment: Australia—"The Progress of Metallurgy at Broken Hills, N.S.W." M. R. McKeown. *Chem. Eng. and Min. Rev.,* Vol. 23, No. 267, Dec. 5, 1930.

GRAVITY concentration for production of argentiferous galena concentrate; gravity concentration for galena followed by flotation for recovery of granular zinc blende; gravity concentration for galena followed by selective flotation for recovery of galena and blende from granular de-leaded tailing and from slime; adoption of all-flotation treatment by North Broken Hill, Ltd., and elimination of jigs and tables; flow sheets. —E.I.S. New York.

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Mines and Mining: Ore Handling—"A New and Improved Method for Handling Broken Rock in Flat, Narrow Stopes on the Sub Nigel." S. N. Hoffenberg. *Chem., Met. and Min. Soc. of S. Africa—Jl.,* Vol. 31, No. 5, Nov, 1930.

STOPE track layout and tramming conditions; handling ore trammed from stoping place; methods of stoping and stope widths; use of hand shovels; four-handled scrapers operated by two natives; trays; trays and scrapers versus shovels; saving time and labor on main track of stope; organization of labor; advantages of new method over shoveling on Sub Nigel; opinions of senior underground officials; comparison of new method with mechanical scraping.—E.I.S. New York.

Personal Notes . . . Comment . . . Criticism

Among Our Contributors:

FRANCIS G. HILL was graduated in mining engineering at the University of Johannesburg in 1924, obtained experience underground at the Van Ryn Deep, was awarded a Rhodes scholarship at New College, Oxford, and obtained a degree there in 1929. Post-graduate work in mineralogy was followed by study at the International Management Institute at Geneva. In 1930 he was awarded a scholarship by the Transvaal Chamber of Mines, for one year's research on some problem of interest to the Transvaal mining industry. He elected to study the technique of scientific management and personnel control, and is now on a tour of mining centers in the United States, after a period in contact with the Taylor Society in New York City and observation of methods and practices at universities and industrial establishments in eastern states.

DIPL. ING. KARL BALDAUF is chief engineer of Maschinenfabrik Buckau R. Wolf A.-G., Magdeburg, one of the leading German designers of dredges and excavating machinery.

R. M. P. HAMILTON is a metallurgical engineer with the General Engineering Company, with headquarters at Toronto, Ont., Canada.

EMILIO TEIXEIRA, well known to our readers by reason of former contributions, is a graduate in mining engineering of the University of Illinois. He has had a wide experience in official and professional work in Brazil, the land of his birth.

WILL H. COGHILL is a research metallurgist of international reputation, and the contributor of numerous articles to the technical press. He is supervising engineer at the Rolla, Mo., station of the United States Bureau of Mines.

ELMER ISERN, who will be recalled as the author of "Central Milling in the Tri-State District," which appeared in a recent issue, is the metallurgical engineer of the Commerce Mining & Royalty Company, at Miami, Okla.

COL. PERCY E. BARBOUR, a consultant of New York, was on the editorial staff of *Engineering and Mining Journal* about fifteen years ago after an engineering experience in various mining regions, particularly in connection with the mining and metallurgy of copper ores. He subsequently served as editor of *Mining & Metallurgy* and assistant secretary of the A.I.M.E., later as secretary of the M.M.S.A. He is an officer of the Reserve Corps of the United States Army.

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Bert Ashley, discoverer of the Ashley gold deposit in Bannockburn Township, Northern Ontario, has been in New York for the last month.

R. J. Lemmon, metallurgical engineer, Imperial Chemical Industries, is making a short visit to the Union of South Africa and the Rhodesias.

Cyril Emery, general manager of North Broken Hill, Ltd., has been appointed consulting engineer to Widdin Baerami Shale Oil & Coal, Ltd.

L. B. Mowry has gone to Russia from the United States to supervise the erection of Herreshoff furnaces exported to the U.S.S.R. He is expected to return in three or four months.

F. H. Cardiff, F. White, and **J. G. Brittingham,** recent graduates in metallurgy at the University of Melbourne, have joined the staff of Wiluna Gold Mining, in Western Australia.

Ivor Bassett, recently with Granby Consolidated, at Anyox, B. C., is now conducting flotation tests and research in the concentrator of Hudson Bay Mining & Smelting, at Flin Flon, Man.

James H. Pierce, vice-president of Stuart, James & Cooke, left New York on April 14 to visit his company's offices in Kharkov and Leningrad, U.S.S.R., and for a short visit to the London office.

E. W. Skeats, professor of geology at Melbourne University, will represent the Australian and New Zealand Association for the Advancement of Science at the centenary meeting in London in September.

Gordon R. Campbell resigned, on April 20, from the presidency and board of directors of Calumet & Arizona Mining. He had been president of the company since 1921, having held the post of secretary prior to that time.

George E. Farish, of New York, sailed from New York for Greece on professional work on April 11. Before returning he expects to visit Italy. His address for the remainder of the year will be: c/o Banca d'America e d'Italia, Naples.

Philip Ivanoff, a former Russian mining engineer, now consulting engineer for Lena Goldfields, Ltd., arrived in New York recently from London, to observe demonstrations of the new Kingsley process for the reduction of lead concentrate.

S. Smith Meyer, of Evje, Norway, who has spent the last few months studying flotation in the United States and Canada, left New York for Norway on April 17. During his trip he visited plants in Sudbury, New Jersey, Missouri, Colorado, Utah, and Montana.

Theodore Marvin, for eight years editor of *The Explosives Engineer,* has been appointed advertising manager of the Hercules Powder Company, succeeding Nelson S. Greensfelder, who died on April 5. Mr. Marvin is a graduate of the Colorado School of Mines. His appointment becomes effective immediately.

Arthur J. Bensusan is spending several months in Brazil on professional business. Mr. Bensusan was for 21 years general manager of the Passagem mine of Ouro Preto Gold Mining in Minas Geraes, Brazil. Since 1925 he has occupied a similar position with the Abontiakoon company and the West African Diamond Syndicate, on the Gold Coast, Africa.

Ben H. Jackson was elected president, **Senator Frank Whiteside,** vice-president, and **Shelton Hampton,** secretary and treasurer, of the newly formed Vigilante Mining Association, an organization to further the interests of mining in southwestern Montana. The association is the outcome of a gathering of mining men at Three Forks, Mont., on April 3 and 4.

W. R. Wade has been elected president and managing director; **Kirby Thomas** and **Harris Hammond** vice-presidents, of Golden Chariot-War Eagle Mines, on the treasury stock of which Engineers Exploration Syndicate recently took an option. Mr. Thomas, who organized the undertaking, is consulting engineer. The properties, near Silver City, Idaho, are to be developed through the Sinker Tunnel.

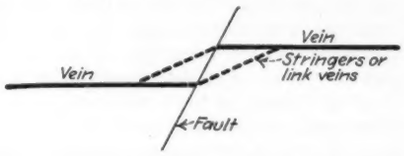
PERSONALS constitute an attractive feature of a magazine of this type. Probably the most interesting ones record changes in employment. If a reader is promoted in his organization, or leaves one company to join another, he should keep his scattered friends informed of his movements. Of only negligible interest to the mining fraternity are notifications that short inspection trips and vacations have been taken. Engineers, particularly mining engineers, are normally peregrinating creatures. News items of journeys to little-known districts, or in connection with important missions, are most welcome, especially when accompanied by short personal comment of an informative or critical nature. When notifying us of change of address, the subscriber is urged to say a word or two about himself or one of his friends. At other times, send a note direct to the Editor, remembering that personal or pictorial photographs are occasionally used to lighten the text.

Ore Guides

To the Editor of "E.&M.J.":

Mr. Roland Blanchard's article on ore guides in the issue of Feb. 23 brings to mind a number of things I have observed along that line that might prove very useful as guides in picking up faulted orebodies.

The vein of the Hillside mine, Yavapai County, Ariz., is cut by a number of faults of small displacement. Besides the fault matter, there are, as guides, in every case, small stringers of ore or a characteristic fracture joining each end of the faulted vein with the side of the vein on the other side of the fault, as shown in the illustration. These stringers I call link veins. I have frequently observed this linking of faulted parts of veins in other places. The same linking occurs after a vein has been cut by a dike. Sometimes a faulted vein will link up with a faulted dike if it happens to be close by. Often these link veins are quite rich; they are probably the principal reason why vein crossings are often richer than the rest of the vein. The explanation of the link vein is probably that the vein has been reopened after faulting. The reopening has linked the faulted parts.



Another guide, or rather a warning: In one mine I visited several years ago the character of the ore in the vein changed suddenly. At the point of change was a slip. On the surface at this point dikes showed a fault of about 300 ft. This slip was a fault, but, unlike most faults, had no fault matter. It was or had been a deep-seated fault which had been brought near the surface by uplift and erosion. Deep-seated faults have no fault matter. These deep-seated faults when found near the surface are, as a rule, old faults. The time it would take to erode enough material off of them to bring them near the surface indicates that. The owners, not suspecting this slip was a fault, have never hunted for the faulted part. They followed a link vein which had probably joined up with some dike.

WILLIAM CROCKER.

Prescott, Ariz.

Labor Factor in Gold Mining

To the Editor of "E.&M.J.":

In a recent issue an article by S. D. Strauss, entitled "The Labor Factor in Gold Mining," gives statistics of the annual output during recent years in short tons per man employed in gold mining in Western Australia, Witwatersrand, Porcupine, and Kirkland Lake, as follows: Witwatersrand, 140; Western Australia, 190; Kirkland Lake, 500; Porcupine, 700. The Western Australia figure is accepted by Mr. Strauss as indicative of the general efficiency of mining and metallurgy at Kalgoorlie, the important gold-mining center; and from this figure, which will be shown to be far too low, certain broad conclusions are drawn, which, if left uncorrected, may convey an erroneous conception.

In a report dated December, 1926, on the gold-mining industry at Kalgoorlie, Mr. W. E. Wainwright, general manager of Broken Hill South, states that in 1914, 1,250,000 tons of ore was mined at Kalgoorlie and the number of men employed at the mines was 3,000, equivalent to 400 tons per man-year employed. Mr. Strauss' 1914 figure for Western Australia, which he takes to mean Kalgoorlie, is 258. The Western Australian figure, however, is almost the same as for Porcupine in that year. During a recent year one Kalgoorlie property mined and treated 98,253 short tons. The total number of employees of all classes, including staff, engineering, mill and mine, was 319, giving a labor efficiency figure of 308 tons per man-year. This figure, which compares with one of 182 given by Mr. Strauss for the same year, may be regarded as typical of other Kalgoorlie mines. There is thus no justification for the statement that "the miner at Kalgoorlie produces one-third to one quarter of the tonnage of the miner at Timmins or Kirkland Lake."

In making an efficiency comparison, Mr. Strauss should have taken the tonnage of ore mined at Kalgoorlie itself, not Western Australia as a whole, and the number of men employed there. The total number of men employed in gold mining in Western Australia, where there are many small mines, includes prospectors, those at work on private and syndicate properties, in small companies, and in government-controlled batteries, of which there are almost 40. Obviously, these men constitute a large proportion of the 4,000 gold-mining employees in Western Australia in 1929. In that year probably only 2,000 men were employed in Kalgoorlie itself.

Any comparison of mining efficiency at Kalgoorlie would be incomplete without reference to the general conditions of mining there. The Kalgoorlie field, 400 miles from a seaport, suffers the general disabilities that follow such isolation—particularly high transport costs. No fuel is available within 100 miles of the mines. Wood is used in most of the Kalgoorlie power plants at a cost of 15s. per ton delivered; the cost of power is high at 1.25d. per kilowatt-hour. The cost of compressed air is usually 2d. per 1,000 cu.ft. Water costs 2s. 6d. 3s. per 1,000 gal. Explosives and mine timber are very costly. The ore is complex and usually requires roasting or concentration and roasting, prior to cyanidation. A high protective tariff on machinery, plant, and equipment greatly increases the capital cost of new installations. Frequently, the cost of a machine is double the overseas purchase price before it reaches the field. Most of these factors, which add greatly to the cost of mining, are not within the control of the mining engineer.

The decline of gold mining at Kalgoorlie has been the subject of numerous reports by governmental agencies. The last, prepared by the Development and Migration Commission, was dated 1927. In this report, based on a detailed report by W. E. Wainwright, it was recommended that the seven mines then operating should be amalgamated into two large properties at the western and eastern sides of the field. The western group comprises Great Boulder, Lake View & Star, and Golden Horseshoe Estates; the eastern, Associated Gold Mines, South Kalgurli, Boulder Perseverance, and Oroya Links. Consolidation of the western section is in part complete with the recent merging of the Lake View and Golden Horseshoe, under the general managership of J. F. Thorn. There is little doubt that the future of Kalgoorlie is dependent on the treatment of larger tonnages, thus giving reduced costs and increasing ore reserves. Amalgamation of the small units into larger ones is the obvious method.

Costs at Kalgoorlie today range from 28s. to 42s. per ton, treating tonnages of 7,000 monthly. The estimated cost of the Wiluna company, which will soon be treating 40,000 tons monthly, is 19s. per ton, a figure directly comparable with the cost of mining on the Rand today. The effect of increased tonnage on the Kalgoorlie costs would be marked, and would make payable huge tonnages of low-grade material. At Kalgoorlie to date 30 million tons of ore has been treated to yield 18 million ounces of gold and 2 million ounces of silver. Expert opinion is to the effect that there is a distinct possibility of high-grade ore being located, apart from the low-grade material of the existing orebodies.

HAROLD S. ELFORD.

Melbourne, Australia.

To the Editor of "E.&M.J.":

In reply to Mr. Elford's comments: It is conceded that comparison of figures for an entire province with those for a district is inadmissible, but individual figures for Kalgoorlie for the last 25 years were not available. However, the article was not so much concerned with the relative output of a Western Australian miner as with the fact that in the last 25 years apparently no improvement has been made in tonnage per man, although wages have risen. The statement—the main point of the article—that Western Australia has been slow to adopt modern machinery is supported by Mr. Elford's citation of high power costs resulting from the use of wood-burning plants. Installation of Diesel engines at Wiluna and Lake View & Star proves that this type of power is feasible. In conclusion, I did not intend to give the impression that Kalgoorlie alone was being compared with the Rand. The word Kalgoorlie itself occurs only twice in the article, and all the statistics are clearly labeled as pertaining to the entire State of Western Australia.

S. D. STRAUSS.

New York, N. Y.

OBITUARY

Andrews Allen, consulting engineer, and president of Allen & Garcia, of Chicago, died suddenly recently at Jasper, Ala.

F. A. Flindt, of Salt Lake City, died on April 10, following an operation in a San Diego, Calif., hospital. He had been ill for several years, and was seriously stricken a few weeks before his death while on a vacation in California. Mr. Flindt was active for many years in the Park City district of Utah. He was subsequently associated with the Gunn-Thompson interests, and while scouting for them he bought the Magma copper properties in Arizona and most of the properties that now comprise the Texas Gulf Sulphur Company.

INDUSTRIAL PROGRESS

New Ventilating Blower Requires Less Space Than Centrifugal Fan

Other Recently Introduced Equipment

REASON exists for believing that the conventional heavy slow-speed mine-ventilating blower will soon be replaced by more modern and efficient equipment. Improvements in mining methods and administration have called attention to the desirability of improving the means of air supply, according to J. D. Schmidt, of the Westinghouse Electric & Manufacturing Company.

The centrifugal ventilating fan is inherently a slow-speed piece of apparatus and labors under the handicap of requiring either reciprocating engines or large slow-speed motors or some form of speed reducing means. To take its place, a propeller-type blower of greater efficiency and vastly smaller weight and physical dimensions is now available.

The propeller blower, unlike the centrifugal fan, is inherently a high-speed mechanism, and for this reason makes possible such radical reductions in space occupied. It is not new in principle, for small blowers of this type have been employed for years for special forced-draft applications where only small quantities of air are required. It is new, however, in detail and superior in efficiency to any of its predecessors, because it represents the result of a long and painstaking theoretical study of propellers and of fluid flow and intelligent design which has produced an apparatus of great simplicity and dependability.

One of the desirable characteristics of this blower is that it is susceptible of an almost limitless variety of arrangement, and may be placed either horizontally or vertically or at any desired angle. It requires little in the way of foundation, since it is directly driven either by motor or by steam turbine as the application may require, and there are no reciprocating or unbalanced parts, the energy of which must be absorbed by the supporting structure.

That the attention of the mining industry is being centered upon this new development may be observed by the fact that two large mining companies, the Westmoreland Coal Company and the Anaconda Copper Mining Company, have already placed orders for apparatus of this type. The Anaconda company has purchased for one of its mines in Butte a propeller blower of 300,000 cu.ft. per minute capacity. This application is of more than ordinary interest because the air to be handled is heavily laden with sulphurous fumes and for this reason the entire inside of the blower and all its working parts must be coated with metallic lead to prevent rapid corrosion.

Confidence is expressed that other mining operators will soon perceive the advantages of this type of blower, and it is likewise probable that other industries will also realize its flexibility of application.

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Determining Individual Gases

A device, known as the Vulkan gas indicator, which is intended for use in detecting and determining individual gases in gas-air mixtures, has been developed by Vulkan Works, Ltd., Gutersloh, i.W., Germany. In the United States, the manufacturers are represented by Industrial Apparatus & Instrument Company, Inc., 241 Springfield Ave., Newark, N. J. Among the purposes for which the indicator is said to be suited are the following: Prevention of explosive mixtures in mines; detection of leaks or breaks in gas pipes; investigating poorly ventilated inclosures; determining the presence of poisonous gases after fumigating buildings; and general use in chemical industries. In view of the manifold applications of the device, three distinct types were developed: Type G, for preventing explosive mixtures in mines; Type K, for tunnels and foundations; and Type J, for factories, laboratories, and hospitals. The indicator's effectiveness is based on the diffusability of gases, diffusion being the physical property of two gases to mix independently of outside forces.

This automatic sampler is intended for mill launders 6 to 20 in. wide

Recording Smoke

A device for recording smoke, as a means for maintaining minimum smoke conditions to meet ordinance requirements or for purposes of economy, has been developed by Leeds & Northrup Company, Philadelphia. The complete installation comprises a measuring chamber at the stack or breeching, a recorder at any convenient location, and an indicator at the boiler. The measuring chamber, through which the smoke passes, contains a lamp at one end and a specially constructed temperature compensated thermopile at the other. Heat radiated from the lamp passes through the smoke-filled chamber and falls on the thermopile. With a constant heat source in the lamp, the amount of heat falling on the thermopile is inversely proportional to the density of the smoke. The heat from the lamp which reaches the thermopile causes it to generate a voltage. Measurement of this voltage is the measure of the smoke density. The recorder is one of the company's standard potentiometer recorders. The boiler room indicator is a bank of five lamps, which instantly tells the fireman the smoke condition.

Another Mill Sampler

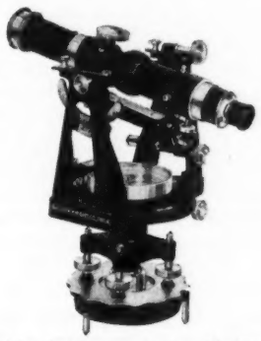
A new Geary-Jennings sampler, smaller and more compact, and designed especially for mill launders 6 to 20 in. wide, has been introduced by the Galigher Company, Salt Lake City. It is operated automatically by a Telechron motor and timing switch. Motor bearings are sealed in oil to exclude dust. Likewise, all parts of the new sampler are designed to operate under dusty, moist, or steamy atmospheric conditions. The cover can be locked, preventing interference. Two styles of wet cutters are provided, one for the usual type of launder with a slope of 1 to 2 in. per foot; the other for use in sampling discharge from a vertical type or spout. Both are made of cast iron, and are attached to the carrier bar with U-bolts, permitting adjustment in height. The

sampler is also furnished with a third type of cutter for use on dry materials. The cutter travels in a straight line at uniform speed, the travel being 24 in. maximum and 15 in. minimum.

For the Surveyor

A so-called "Transit-Level" of a new design has been introduced by Warren-Knight Company, 136 North 12th St., Philadelphia, Pa. The instrument has a new optical system and new dual bearing standards, a feature which permits the adjustment of the telescope and level to be checked as easily and in the same way as in the ordinary wye level. The new model is said to be the result of the demand for an accurate and dependable instrument combining both transit and level, without need of changing the instrument in any way. It is shown in an accompanying cut.

The horizontal circle is held in position by automatic spring tension and is set to zero reading by hand. In this instrument the telescope cannot be



This instrument combining both transit and level may be adjusted with ease

plunged through the standards, and is provided with bell-metal collars like those on a wye level. The tops of the standards form dual bearings, a V and a wye in each, the telescope axle being normally held in the V bearing by spring clips with provision for instant release. The telescope and axle can be lifted out of the V bearings (the normal working position) and the telescope rested in the wye bearing for checking the adjustment in the same manner as with a wye level.

Increasing Belt Conveyor Life

W. E. Philips, engineer of the Link-Belt Company, Chicago, cites five ways of increasing belt-conveyor life. These are: Proper lubrication; cleanliness, with reference to the space under the belt as well as to the decking when the material overflows and threatens to clog the idlers; avoidance of overloading by using an idler of proper weight and a belt designed for the desired service; avoidance of unnecessary wear caused by belts breaking against framework and other parts; and proper training of the belt, which should be done when the belt is empty. (If the belt gets out of alignment when loaded it is because of unequal loading.)

Heavy-Duty Apron Feeder of Manganese Steel

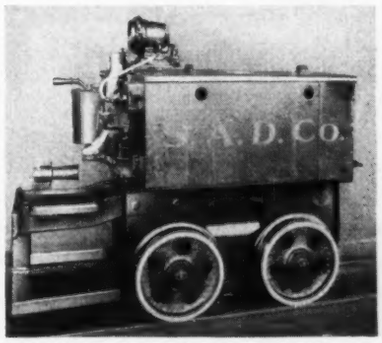
A new feeder of manganese steel for handling either abrasive or non-abrasive material containing lumps of ¼-in. size has been introduced by the Link-Belt Company, Chicago. It can be had up to 6 ft. in size, being especially well adapted to handling very heavy, large, lumpy and abrasive materials. Sprockets, chains, rollers, and overlapping non-sagging apron pans are of cast manganese steel. The pans are ribbed and ⅜ to 1½ in. thick. The chains have no small rollers and are placed under the pans so as to break up the span of the latter. They are protected from dirt. The broad wearing surfaces of the links form substantial tracks for the large manganese steel rollers which support the material-carrying run. These rollers are closely spaced.

Multi-Speed Drive Combined With Motor

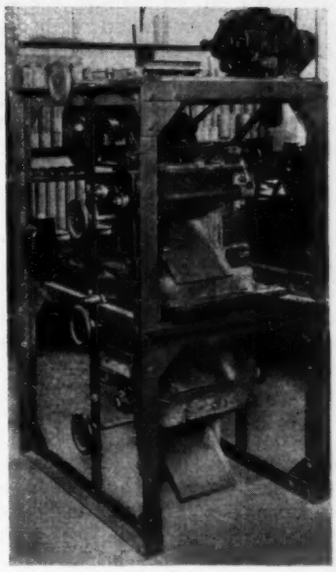
Roy T. Wise, consulting engineer for the Westinghouse company, has developed a multi-speed reduction gear unit built in combination with a standard a.c. motor. This is known as the Westinghouse-Wise multi-speed drive and is built to give four different speeds at the output shaft at constant horsepower. It is intended for those operations requiring drives providing more than one speed. With it the speed of the driven apparatus may be changed instantly while the motor is running at full speed and under full load. All gears are constantly in mesh and the unit cannot be injured by changing speeds. The new drive is offered in three units ranging in rating from ½ to 7½ hp. The four speeds available in the gear drive itself, plus the availability of motors giving different driving speeds, make it possible to choose a combination that covers a wide range of speeds.

A Locomotive on Mule-Back

The midget locomotive shown in the accompanying illustration was supplied by the South American Development Corporation, New York, for its mine in Zaruma, Ecuador. The locomotive, weighing 3,300 lb., was disassembled and transported into the mountains by pack mules.



This 3,300-lb. midget locomotive was disassembled and carried on mule-back into the mountains in Ecuador



Efficient work may be done on feebly magnetic material, it is claimed, by this induction separator

Induction Separation Employed

An induction separator which is said to provide efficient magnetic separation of so-called non-magnetic material, as well as of material hitherto unresponsive to the highest-intensity magnetic separator of the usual type, has been developed by Magnetic Manufacturing Company, Milwaukee, Wis. It is constructed so as to provide intense magnetic pull with low power input and correspondingly low current consumption. It is arranged to give three or more stages of magnetic separation, according to requirements. The capacity is 10 or more tons per hour. The unit has no conveyor belts or material actuating pulleys.

A New Mechanical-Drive Turbine

A bulletin has been issued by the Elliott Company, Jeannette, Pa., describing a new single-stage, mechanical-drive turbine built in sizes ranging from 5 to 60 hp. When lagged and built with a cast-steel casing and steam chest, this turbine is suitable for operation at 400-lb. steam pressure and 700-deg. temperature. Its design has many features of larger turbines for driving generators such as a horizontally split casing, steam and exhaust connections in the lower half of the casing, a stiff shaft rotor which is balanced both statically and dynamically, and an emergency overspeed governor separate from the constant speed governor. Each governor actuates its own valve, supports providing for both axial and lateral expansion.

Another New Floodlight

A 100-watt general-utility floodlight projector, known as the "Novalux Handy" floodlight, has been announced by General Electric. It is much smaller than the usual projectors and is expected to find application wherever lighting

requirements do not call for the larger standard units. The new projector weighs less than 3 lb., is less than 9 in. wide, 10 in. deep, and 13 in. high, and is built for 100-watt inside-frosted, general service, incandescent lamp with a $4\frac{3}{8}$-in. light center and a medium screw base. The unit has a combination casing and reflector of sheet aluminum.

Welding Spiral Pipe

Spiral welded pipe, said to be the latest development in the field of pipe manufacturing, is being produced by the American Rolling Mill Company, Middletown, Ohio. Its advantages are said to include lighter weight, easier handling, and increased length of sections, this reducing the number of field joints; a smooth inside wall, reducing friction and pumping costs, together with lessened shipping and handling costs. This pipe may be had in sizes ranging from 6 to 24 in. in diameter, and in any wall thickness from 12 gage to $\frac{1}{4}$ or $\frac{3}{8}$ in. It may be had with any coating—that is, mill coat, asphalt inside and out, or galvanized.

Miners' Safety Hat Improved

Greater flexibility has been obtained in the new hard-boiled hats and caps made by E. D. Bullard Company, San Francisco. This makes the hat more comfortable, as it may be shaped to fit the wearer's head. It likewise makes the hat a better protector against falling rock, inasmuch as more of the force of the blow is absorbed by the hat. Another feature of the hat is the new so-called hammock, consisting of four broad strips of heavy fabric which increase the strength of the hat and improve the ventilation.

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Moves Head Office

Traylor Engineering & Manufacturing Company, Allentown, Pa., has moved its New York office, in charge of R. R. Shafter, from 30 Church St., to the newly erected Empire State Building.

Pumping from "Submerged" Station Controlled Automatically

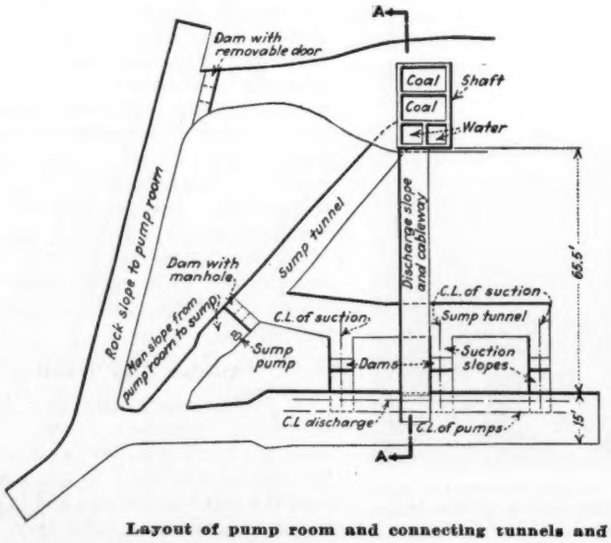
IVAN A. GIVEN, in a recent issue of *Coal Age*, tells how a drainage problem was solved at the William Penn Colliery, Shenandoah, Pa., by the substitution of a submerged pump room with automatic contrifugal pumping for the old water hoist which served the colliery for about 27 years. A difficult problem had to be solved in that at times the water stands above and at other time below the pumps. If the water were either always above or always below the pumps, standard equipment for either submerged or suction-lift stations could have been employed. Or if the pumps during the wet season worked with a positive suction head and during the dry season with a suction lift, transfer switches and valves could easily have been arranged to bring the proper equipment to service. However, at this colliery the change from positive to negative suction head may take place at any time, and manually operated transfer apparatus was out of the question.

The present drainage plan is shown by the accompanying sketches, of the layout of pump room and connecting tunnels and slopes. To reach the old sump from which the water hoist operated, a rock tunnel was driven from the pump room. This opening connects with another tunnel paralleling the pump room, the latter being connected to the pump room by three rock slopes in which the suction pipes are laid. The discharge column is placed in a rock slope entering the shaft at a point 53.6 ft. above the fourth level. Access to the room is through the 26-deg. man slope shown.

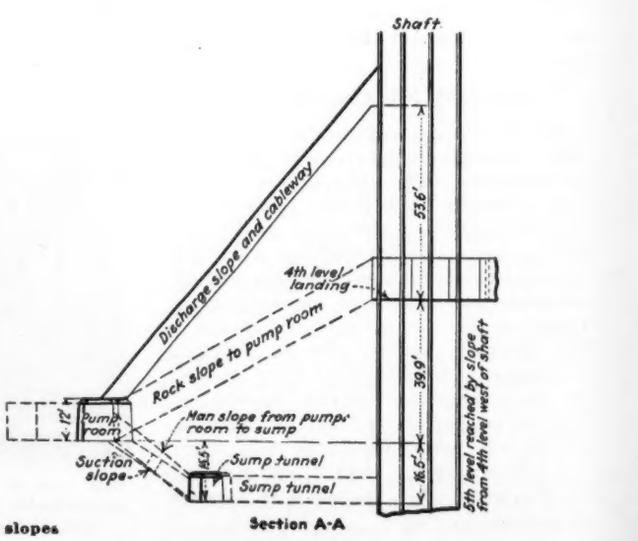
Two 8-in., eight-stage, 1,500-g.p.m., bronze, turbine centrifugal pumps, each made up of two four-stage pumps in series, were installed in the pump room. These were built by the Scranton Pump Company; each unit, consisting of two pumps in series, is driven by a 500-hp. G. E. synchronous motor with direct-connected exciter. Both units are designed to work against a head of 975 ft. and are equipped with a 12-in. suction line and a 10-in. discharge line. The latter in turn is connected to a pump column made of 15-in. cast-iron wood-lined pipe. Vertical lift from the pump to the surface is 920 ft. A third unit of the same capacity as the others can be installed in the pump room if conditions require it. Barrett-Haentjens 50-cu.ft. priming pumps driven by Westinghouse 5-hp. motors, together with Barrett - Haentjens automatic control system and Electric Controller & Manufacturing Company automatic starters, are used in priming and starting the pumps.

To have the equipment function automatically under the two conditions mentioned in the first paragraph an artificial suction lift was created when, at starting, the water happened to stand above the pump, so that standard electrical control for suction lift pumps could be used. This was accomplished by using a priming valve, which is always closed except during the priming period, when it is held open by the vacuum produced by the priming pump. The priming pump therefore must always be started. even when the water stands above the pump, and through its suction effort the valve is first opened, and the air tapped in the pump casing is then drawn through the valve ports and piping into the vacuum breaker.

The volume of water to be handled is indicated by the fact that in the period Oct. 1, 1927, to Sept. 30, 1928, inclusive, 489,000,000 gal. was hoisted, an average of 930 g.p.m. The minimum monthly volume in that period averaged 470 g.p.m. and the maximum 1,340.

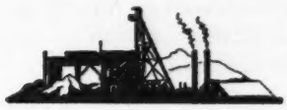


Layout of pump room and connecting tunnels and slopes



Section A-A

NEWS OF THE INDUSTRY



Claim Use of Methane Would Lower Zinc-Reduction Costs

The equivalent of coal at $1.20 a ton represents the fuel-reagent expense of the new methane-gas process of zinc reduction made public at the meeting of the American Zinc Institute, St. Louis, by R. S. Dean, chief engineer, metallurgical division, U. S. Bureau of Mines. The process, expected to have a revolutionary effect on production of metallic zinc from relatively low-grade ore, is the invention of Charles G. Maier, metallurgist at the Pacific experiment station, Berkeley, Calif. It follows three years of experimental study by the U. S. Bureau of Mines to determine if zinc-smelting costs could be reduced and high quality maintained. In view of the recent decreasing returns from zinc production, this solution is timely.

Mr. Maier, formerly of Sharon, Pa., graduated from Massachusetts Institute of Technology and was a research fellow at the University of Utah. By his invention, zinc of electrolytic purity is producible with comparative economy.

This new process uses about 12,000 cu.ft. of methane to produce 1 short ton of zinc. In previous practice, about 1 ton of coal was required for the same purpose. Methane, if completely utilized as a reagent at 10c. per 1,000 cu.ft., is thus equivalent to coal at $1.20 per ton. The process operates at temperatures of 900 to 1,000 deg. C. The heat required to maintain this temperature is very much less than that necessary for the present retort at 1,200 to 1,400 deg. C. The thick clay retorts now used are poor conductors of heat. At temperatures below 1,000 deg. a metal retort with its better conductivity is a possibility.

The gaseous product of methane reduction contains 50 per cent hydrogen and equal parts of carbon monoxide and zinc vapor. Hydrogen is an excellent conductor of heat contrasted with the gases of the old process, which were composed of carbon monoxide and carbon dioxide. Gases in the retort are much better conductors and will increase the thermal efficiency. The old zinc-smelting process is intermittent and therefore thermally inefficient. Continuous counter-current operation in the methane process is not only feasible but practically essential. The thin front wall of present furnaces radiates large quantities of heat. Retorts using gas for reduction can be inclosed in furnaces having well insulated walls on all sides. Replacement of retorts and furnace linings is a big item in the cost of operation. At temperatures below 1,000 deg. C. the life of refractories is much greater and the ore is much less likely to fuse, stick to, and damage the retort. With continuous operation, as made possible by the use of gaseous fuels, labor is reduced to a small item. Low temperatures, which eliminate fusion of the retort residue, continuous counter-current operation, and low content of carbon dioxide in the gases, are conditions favoring a high recovery.

With the use of carbon for reduction, the zinc vapor is expelled from the retort by the pressure of the gases evolved. The gas pressure decreases as reduction proceeds, so that the last portion of the zinc cannot be profitably extracted. With gas as the reduction agent, instead of carbon, the continuous gas stream will permit effective removal of the last traces of zinc in the retort. Further utilization the fuel value of the gas for heating the charge is possible.

Zinc ores generally contain lead, some of which is carried over with the zinc vapor during the distillation process, contaminating the zinc. With reduction below 1,000 deg. C., very little lead will volatilize. The new process therefore makes possible treatment of ores with a higher lead content and widens the scope for treatment of zinc ores.

Formation of blue powder in the condenser should be practically eliminated by the new method. Most of the modern zinc smelters and gas producers convert coal to gas fuel. By the use of methane gas, there will be no expense for gas-producer equipment.

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F.M.S. Adopts Legislation for Tin Export Quota Plan

The Federated Malay States has passed legislation for the enforcement in that country of the two-year international plan for restrictions of tin production and exports, according to a cablegram received in the U. S. Department of Commerce from Don C. Bliss, Trade Commissioner, at Singapore. Restriction has been provisionally in effect from March 1 by agreement of a majority of the producers, of the four leading tin-producing countries—the Federated Malay States, the Netherlands East Indies, Bolivia, and Nigeria.

On March 18 the Governor General of the Netherlands East Indies announced the participation of that colony in the tin restriction plan beginning March 1. It is understood that no legislation enforcing tin restriction has as yet been enacted by the governments of Bolivia and Nigeria, representatives of which participated in drawing up the agreement.

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Drilling Started at Marana Group in South Tintic Area

Marana Mines Corporation, headed by J. R. Van Evera, of Salt Lake City, has started to diamond drill its ground, in the South Tintic district of Utah, to ascertain the depth of the surface volcanic breccia and tuff, the distance to the limestones, and the character and the thickness of the sedimentaries. The contract was awarded to the Boyles Brothers Drilling Company, of Salt Lake City and Vancouver, B. C.

The claims, numbering 200, were located several years ago by Mr. Van Evera, who with his associates will seek to prove that the monzonite area at Diamond City (believed responsible for the extensive and rich mineralization in the Tintic district to the north) has had a similar influence on the formation to the south.

Campbell Out, Office Changed in C. & A. Proxy Fight

Gordon R. Campbell, of Calumet, Mich., for the last ten years president of Calumet & Arizona Mining, resigned both that position and his place on the board of directors of the company at the annual meeting at Warren, Ariz., on April 20. His resignation was the direct result of a contest for control of the company and was further reflected in the decision to move the offices from Calumet, Mich., where they have been ever since the company was started, to New York City.

Early in March, the fact became known that a struggle for control of Calumet & Arizona was under way. In a letter to stockholders, Mr. Campbell stated that certain interests desired to move the office of the company to New York and that he was personally opposed to any change. He stated that it was his belief that location of the office in Calumet had saved the company a large amount of money in rentals and salaries—as the production is sold under contract by Phelps Dodge. He also declared himself opposed to the proposed merger with Phelps Dodge. If defeated on the issue of moving the office, he stated that he would resign.

A rival committee, in which the leading spirits were Charles Briggs, T. F. Cole, W. B. Mershon, J. C. Rea, L. D. Ricketts, and H. DeWitt Smith, declared that the directors had voted in favor of moving the offices to New York because such a step would put the company in closer touch with the copper industry and the business world. The committee also declared that C. & A. is now operating at a lower rate of production than any other substantial copper company.

At the meeting, no successor to Mr. Campbell as president was elected. His place on the board of directors, however, was filled by Thomas W. Lamont, a partner in J. P. Morgan & Company. Alexander C. Tener, of Pittsburgh, was elected to succeed George Ruppe, of Columet, who also resigned. James C. Rea was elected vice-president, succeeding F. J. Kohlhaas.

At the Phelps Dodge annual meeting, held in New York on April 21, Cleveland E. Dodge, vice-president of the company, stated that negotiations looking to a merger between Phelps Dodge and Calumet & Arizona will soon be resumed. He characterized the possibilities of the amalgamation as "still very indefinite." He said he did not believe that the defeat of Mr. Campbell had had any connection with the merger negotiations.

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Bulolo Dredges on the Wing

On April 1, airplane transportation of gold dredging equipment began at Salamoa, New Guinea. Bulolo Gold Dredging is starting the erection of two gold dredges upon its placer properties in New Guinea. Airplane transportation of the dredge parts makes the enterprise of unusual interest.

American Zinc Institute Indorses Market-Broadening Program

Plan Specifies Standard Coatings for Galvanized Sheets and Adoption of a Quality Seal—Similar Action Meets With Success in Canada

H. D. KEISER
Assistant Editor

A DEFINITE PLAN for increasing the use of zinc by the adoption of specific standards in the manufacture of galvanized sheets was proposed and indorsed at the thirteenth annual meeting of the American Zinc Institute, held in St. Louis, April 20, 21, and 22, and attended by more than a hundred members and guests. An adequate protective coating of zinc, resulting in a longer-lived product, is the fundamental requisite in promoting a wider use of galvanized sheets, said Julian D. Conover, secretary of the Institute, in presenting the organization's galvanizing program. In substantiation of this statement, he not only pointed to the results obtained from a thorough investigation of consumers' requirements that was made by the Institute during the last year, but also referred to the success of similar action on the part of Canadian manufacturers. Adequate advertising, stressing the advantages of the standard product, and the stamping of these products with an Institute seal, indicative of high quality, are included in the plan.

R. M. ROOSEVELT

The annual election of officers of the Institute resulted in the re-election of the following: R. M. Roosevelt, president; A. P. Cobb, John A. Robinson, and J. O. Elton, vice-presidents; Howard I. Young, treasurer; and J. D. Conover, secretary. The following nine directors, succeeding those whose terms expired this year, were elected for the term expiring in 1934: A. E. Bendelari, J. A. Caselton, C. M. Chapin, Jr., F. Childress, A. P. Cobb, A. J. McKay, C. T. Orr, W. N. Smith, E. H. Wolff.

A cordial address of welcome, extended by Guy M. Wood, associate city counselor of St. Louis, opened the first session of the meeting on April 20. Charles T. Orr, who presided, said in response to the welcome that the members of the Institute looked upon St. Louis as the capital of the zinc industry and had held there thirteen of the fourteen annual meetings of the organization.

In a cable, which was read by Mr. Conover, St. Paul de Sincay, managing director of Vieille Montagne, reviewed the European zinc situation. He stated that the only efficient remedy for existing conditions rests in adapting output to consumption. Enactment of regulations to this end, he maintained, is urgently needed in Europe.

In the afternoon, Edward J. Mehren, vice-president of the McGraw-Hill Publishing Company, speaking on "A Platform for American Business," presented for the consideration of the zinc industry an outline of procedure to avoid a recurrence of the present economic situation. Long-term planning, Mr. Mehren stated, was an essential feature of the platform and should include sales, forecasting, market widening, and research to develop new products and markets. He bespoke on the part of the industry a more optimistic and forward-looking attitude in dealing with the problems confronting it. The session closed with the presentation of reports of committees and an open discussion of the Institute and its activities. A smoker was held in the evening.

Following discussion of the Institute's galvanizing program at the morning session on April 21, four papers dealing with technical developments in the industry were presented in the afternoon. "Zinc Smelting in Mexico," by W. J. Jenni, superintendent of Mexican Zinc, and R. F. Spooner, assistant superintendent, was presented by Mr. Jenni. The paper described briefly the equipment and practice employed at the company's zinc smelter at Rosita, Coahuila, Mexico. Retort furnaces are used, the plant comprising eight blocks, varying in size from 768 to 832 retorts. Two blocks are fired with byproduct coke-oven gas, obtained from a coal company, and six are fired with gas producers. Metal is drawn three times a day and cast in the usual manner. The refinery consists of two reverberatory-type liquating furnaces. Gases from Skinner roasters pass to a contact sulphuric-acid plant, where acid of 98½ per cent strength is produced.

H. A. Nelson, chief of the pigment division, research department, New Jersey Zinc, pointed out in his paper, "Some Developments in the Use of Zinc Pigments," that zinc sulphide is a valuable pigment for exterior paints and especially so wherever the use of a high-hiding-power pigment is involved. Commercial possibilities for this comparatively new member of the zinc pigment family, he said, are most promising. Regarding zinc-dust-zinc-oxide paints, Mr. Nelson, with the aid of test panels from the Palmerton plant of the company, demonstrated the superior protective and adhering qualities of these paints when applied to metal surfaces.

F. S. Naething, manager, Evans-Wallower Zinc, at the conclusion of his paper "Evans-Wallower Electrolytic Zinc Plant," in which he described the principal features of the plant, stated that the outlook for a steady increase in the use of 99.99 per cent zinc is most encouraging. Speaking on "Centralized Milling in the Tri-State District," Elmer Isern, metallurgical engineer, Commerce Mining & Royalty, pointed out that reserves of known and probable ore in the Picher field have been estimated at about the tonnage that the field has already produced. This ore, he said, is scattered over an area of 25 square miles, on which 180 separate milling plants are available. Upkeep of each of these mills, together with the cost of development necessary to yield the tonnage of ore required for its economical operation, becomes a serious financial burden in many instances, rendering operations unprofitable. Satisfactory and recently perfected ore-sampling methods to determine royalty payments, as well as a more extensive use of surface haulage, make centralized milling feasible. The advantages that the large-scale application of centralized milling offers the Tri-State district, Mr. Isern said, will probably be recognized in the near future.

JULIAN D. CONOVER

The annual dinner of the Institute was held in the evening, with Victor Rakowsky presiding. In an address, "The Business Outlook," John C. Howell, consulting economist, presented an encouraging picture of the economic situation and stated that in effecting improved conditions, sales executives must today hold dominating positions in industry.

At the concluding session of the meeting, on the morning of April 22, five technical papers were presented. J. D. Sullivan, of the Battelle Institute, read a report on the embrittlement of galvanized structural steel that contained the conclusions of the sub-committee on embrittlement of the American Society of Testing Materials. A process promising to yield higher recoveries and a product that can compete with the best electrolytic zinc was described by R. S. Dean, chief metallurgist, of the U. S. Bureau of Mines, in his paper, "Reduction of Zinc Ores by Methane." Factors peculiar to methane reduction that make a high efficiency possible were, said Mr. Dean, first, low operating temperature, permitting the use of metal retorts; second, high thermal conductivity of hydrogen and other gaseous products of the process; third, continuous counter-current operation methods employed; and fourth, low radiation losses from retorts, which are inclosed in furnaces having well-insulated walls on all sides. Referring to the two electrolytic zinc processes, Prof. H. R. Hanley, Missouri School of Mines, concluded his paper, "Status of Zinc Processes," with the following remark, which apparently received general approval: "The status of both processes seem to bear the stamp of continuous and potent improvements which should not be interrupted, but we could afford an 'improvement holiday' for an interval if all these energies, equally dynamic, could be directed along the road of accelerated consumption with a one-way ticket." R. B. Caples, general superintendent, Great Falls reduction works, Anaconda Copper Mining Company, in his paper, "Recovery of Zinc from Lead Blast Furnace Slag," said that further applica-

tions, in their present forms, of existing processes for recovery of zinc from slags are limited by supplies of slag containing sufficient zinc for profitable recovery at normal metal prices and by suitable markets for the fume and iron products. "It is doubtful," he added, "that the total production of metallic zinc from retreatment of slags in this country will ever reach an appreciable percentage of the total zinc production of this country."

H. A. Buehler, State Geologist of Missouri, in discussing zinc developments at Pioche, Nev., where Combined Metals and other companies are engaged in extensive development work, said that the lead-zinc ore body there is an intricately faulted limestone replacement deposit. It has been developed for a mile in length, 300 to 600 ft. in width, and up to 40 ft. in thickness. The ore is amenable to the use of flotation methods and averages 20 per cent zinc, 8 per cent lead, 8 oz. of silver, and 0.03 oz. of gold to the ton.

Several of the papers of particular interest that were presented at the meeting will be published in abstracted form in the next issue of *Engineering and Mining Journal*.

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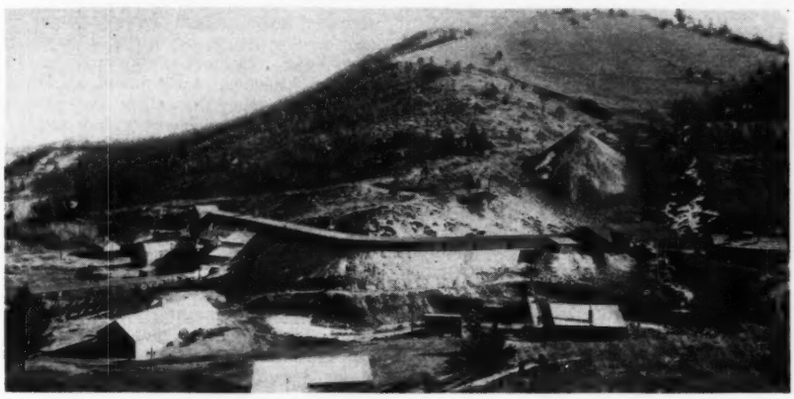

Main tunnel at the Spring Hill gold property of Montana Mines, near Helena, Mont., now largest gold producer in the state.

Treadwell Yukon Increasing Its Interest in Gold Ventures

During 1930, Treadwell Yukon lessened its activities in base-metal mining ventures and increased its activities in gold-mining ventures, according to F. W. Bradley, president, in a statement in the annual report. The company's chief gold properties are the Bodie, in California, in which it has a 60 per cent interest, and a group of claims west of the Ebner properties, in the Juneau district, Alaska, in which it has a 50 per cent interest. Work has just started on the latter. Mr. Bradley states that "The mining chances are that these optioned properties contain a shoot of profitable gold ore; and if such an oreshoot is proven it should yield comparatively quick returns, because all the pioneering work of testing out the most suitable mining and milling methods to be employed has been done by the neighboring Alaska Juneau enterprise." Treadwell Yukon also has a small crew at work crosscutting on the Birum group, near Battle Mountain, Nev., where the company hopes to develop a low-grade gold producer.

Of the base-metal properties, Errington, near Sudbury, Ont., had failed to find ore on the 1,500 level up to April 8. No other work is now being done at this low-grade lead-zinc-copper prospect. At the Wernecke mines, in Alaska, reserves dropped from 146,600 short tons at the end of 1929 to 109,650 tons at the end of 1930. Decline in the price of silver, waning ore reserves, and failure to discover new deposits indicate a life of only one or two years. The mill, now at the exhausted Wernecke mine, will probably be moved to the Silver King, which has the largest tonnage of mill-grade ore in reserve. Production in 1930 was 45,574 tons of milling ore and 2,272 tons of shipping ore. At the Tybo property, an improvement has been made in the grade of zinc concentrate produced and a contract has recently been made that will permit shipping it at a slight profit. Development has maintained ore reserves at about 230,000 short tons, but the grade of ore has been improved.

At Bodie, options have been secured on four additional groups, comprising 32 claims, so that the property now includes the entire mineralized area in the district that holds favorable chances. Operation of the high-grade Red Cloud stamp mill and the low-grade Standard Hill flotation mill is expected to yield sufficient revenue to maintain development during the year. In the Noonday vein system, work on the 700 level opened an orebody 135 ft. long and 4 ft. wide that assays $123 in gold per ton, the high assay being due to a high-grade hanging-wall streak. A raise indicated the ore had no upward trend. A winze was sunk 100 ft. At 50 ft. drifting opened an oreshoot 85 ft. long and 3.3 ft. wide that averaged $25 in gold per ton. At 100 ft., the vein was intersected, but 65 ft. of drifting had not yet reached the vein on April 8. In addition, the company has developed high-grade gold ore in two other vein systems in the Red Cloud area, at the south end of the camp. The low-grade deposit on which tests and development work are now under way is at the north end of the property.

■

Rich Lead Ore From Eureka, Nev.

The richest carload of ore of its kind handled in recent years was received by U. S. Smelting, Refining & Mining at its Midvale smelter, in Utah, from the Vacarro & Gibberlini lease on the Eureka Holly property, at Eureka, Nev., according to M. W. Woolley, western field agent for the company. Smelter returns show that the carload averaged 60 per cent lead.

Yankee Mines Ship Gold Ore

American Smelting & Refining is shipping 50 short tons of ore daily from its Yankee Mines property, in American Fork canyon, 50 miles southeast of Salt Lake City, Utah. This ore is a chalcopyrite carrying about $16 a ton in gold, with some copper and silver. The bedded replacement deposit has been opened for 600 ft. along its strike, according to A. H. Means, manager of the Western mining department. It is 50 ft. thick and 50 ft. wide in its widest place.

Drilling operations in the Park City district are being carried on steadily.

The company's operations at its Estelle unit, in the Cerro Gordo district, Inyo County, Calif., have supplied the Selby smelter of the company with 4,700 tons of dry ore, assaying 38.2 per cent lead, $1.40 in gold, and 26 oz. of silver per ton during the last eighteen months. Two promising deposits have been opened up on the virgin side of the fault that cut off the Cerro Gordo ore body. On one of these, a winze has been sunk 80 ft., proving an orebody 8 to 10 ft. thick.

■

Walker Maintains Reserves

During 1930, a development program was planned and carried on so that a ton of ore was placed in the reserve for each ton extracted at the Walker property, in Plumas County, Calif., according to J. R. Walker, president of the company. Work on the orebodies was undertaken on the Nos. 8, 9, and 10 levels, and the winze on the Central orebody is now being put down below the No. 10. Installation of pumping equipment in the Piute orebody on the No. 10 level has been completed, and development has been resumed. The North orebody, which is the largest and lowest grade in the mine, shows a width of 75 ft. in a crosscut on the No. 9 level.

Little variation was shown in mill results during 1930. The ore handled—518,509 short dry tons—was slightly lower grade than in 1929, the average being 1.67 per cent copper. Gold and silver production showed considerable increases over 1929, the total gold output being 16,899 oz., compared with 15,768 oz. in 1929. Costs were slightly lower, at $2.5066 per ton, compared with $2.5578 in 1929, the reduction being greatest in milling costs. Mining costs were actually a little higher.

■

Siscoe Production Rising

In March, Siscoe Gold, operating a property in Dubuisson Township, near Rouyn, Que., produced $49,739 in gold. probably the largest production of any month in the mine's history. The tonnage milled was 4,626 short tons and the recovery per ton was $10.74. Of the tonnage milled, 75 per cent came from the western ore zone, most of which was stoped on the 300 level. In addition to the stopes already started on this level, 210 ft. of additional ore has been developed in the same zone further to the north. Grade is said to be higher than the mine average.

The same zone is being developed on the 150 and 450 levels. Raises have been started from both the 300 and 450 levels. Shaft sinking has been started, and further development will be undertaken at 600 ft. The present rate of production will almost double Siscoe's 1930 output. With increasing production from the Granada and Noranda properties, a further substantial increase in Quebec's gold output seems certain.

St. John del Rey Prepares to Develop New Level

Two incline winzes are now being put down from the No. 26 level of the Morro Velho mine, operated by St. John del Rey, in Minas Geraes, Brazil. These winzes will develop the main and northwest lodes on what will be the No. 27 level of the famous mine, now continuously operated by one company for 100 years. This will carry the workings down to a vertical depth of more than 7,500 ft. from the surface.

Exploration of the main and northwest lodes at the No. 26 level has resulted in opening up a large quantity of mineral, but of low grade, according to the report for 1930. Of the total length of 1,500 ft. of vein material opened on the No. 26 level, only a quarter is considered payable under present conditions. As a result, ore reserves declined from 1,455,100 long tons at the end of 1929 to 1,278,163 tons at the end of 1930, extraction having been 210,579 tons. In the Nos. 21, 22, and 23 levels, however, several new orebodies of good grade have been developed, encouraging the belief that further lateral exploration will bring good results.

The increase in tonnage from 169,454 tons in 1929 to more than 210,000 tons in 1930 resulted in a considerable reduction in costs. Although the yield per ton dropped 4/3½ from 1929 to 1930, costs dropped 4/6. The current depression, which has affected the other industries of Brazil, has created a plentiful labor supply. Advantage is being taken of this condition, according to Sir Henry Harris, chairman of the board of directors, to carry out vigorous exploration both in the Morro Velho and in the other mines which the company controls. Particularly favorable results were obtained on the Espirito Santo group, and a winze is being sunk from the west end of the main body to develop the property further at depth. The average daily attendance in the mine in 1930 was 1,122. In 1929, the average was only about 915.

Installation of the new underground cooling plant, which treats the air and removes part of the moisture content, was completed in 1930. Great improvements have thereby been secured. A plan is being considered for providing an increased supply of electric power, as requirements have been greatly increased by the cooling plant and the larger tonnage handled. Additions will be made to the reduction works when required, as its capacity was taxed by the 1930 tonnage—the largest ever handled.

■

Fairbanks Dredges Start Early

A mild winter has permitted starting of operations by the dredges of Fairbanks Exploration, at Fairbanks, Alaska, considerably earlier this year than usual. Two dredges were put into operation during the week ended April 11, and the remaining three dredges started during the following week. Last year, the first dredge did not start until late in April and continued until late in December, the length of the operating season depending on conditions in the different areas. The ground dredged in 1930 was generally well prepared, and a satisfactory yardage was handled. The average grade was somewhat better, and costs were lower than estimated for the season.

United States Smelting, Refining & Mining, which controls Fairbanks Exploration, has not published statistics on production In 1929, when the first dredge did not start work till May 3 and when only three of the five dredges operated throughout the season, the Fairbanks district produced $1,145,000 in placer gold. Most of this probably came from the operations of Fairbanks Exploration.

■

May Work Nevada Placer Area

Investigation of possibilities of placer deposits at Rawhide, Nev., is now under way by a field crew of the Hammon Engineering Company, of San Francisco. Old prospect shafts are being cleaned out for preliminary sampling. The area approximates 1,180 acres and is held under lease and option by Idaho Gold Dredging.

■

Hartwell Mine Starts Shipping

Shipments of gold ore from the Hartwell group, in the Baguio district, Philippine Islands, have been started by Benguet Consolidated, which has been operating the group under option. A road has been built to the mine, and an ore bin constructed at the main tunnel, on the Prospector claim. For the present, the ore is being treated at the Benguet mill. According to the annual report of the company, about 1,300 short tons of $60 gold ore was indicated on the property at the end of 1930.

The efficiency of the Benguet mill, at Antomok, has been improving steadily and is now about 95.4 per cent of the gold content. This is considerably higher than the previous average.

■

Gold Hill Drifts on 400 Level

On the 400 level of the Gold Hill Development property, near Round Mountain, Nev., drifting east along the ore has been resumed. On the 225 level of the property, ore has been opened for a distance of 1,115 ft., with widths ranging from 2 to 5 ft. H. A. Johnson, superintendent of the mine, has recommended sinking a winze from the 400 level for at least an additional 100 ft. Two raises have been put up from the 400 to the 225 level, in ore all the way. The straightening of the shaft has now been completed, considerably increasing its hoisting capacity.

Ore reserves on Dec. 31 were estimated at 56,660 short tons, of which 22,660 tons is above the 225 level, 32,000 tons above the 400 level, and the remaining 2,000 tons on the dumps. This is a sufficient supply for about eighteen months of operations at capacity, on the basis of 100 tons daily. Recovery in the mill has been 90.97 per cent of the gold content, or about $8.252 a ton. All costs, including transportation, are about $7.30 a ton.

■

Kennedy Sinks Below 4,800 Level

At the Kennedy mine, near Jackson, Calif., sinking below the 4,800 level has reached a depth, on the incline, of 185 ft. On the 4,800 level the north drift has been extended out 205 ft. Parallel tests are being made with a flotation unit serving five stamps and the remaining mill capacity on amalgamation and vanner concentration with supplementary tube milling of a part of the tailing. Such tests indicate the superiority of flotation.

Importance Sinaloa Gold Find Exaggerated, Report States

Investigation made on behalf of the U. S. Department of Commerce indicates definitely that the early reports of the placer gold strike in Sinaloa, Mexico, were greatly exaggerated [see *E.&M.J.* of April 13]. Discovered by two peons on Jan. 13, the deposit is northwest of San Ignacio, about halfway between that town and Cosala, on a mountain known as El Tambor. It is accessible only on muleback and by that method of transportation is ten hours from San Ignacio.

The source of the gold has been traced to some small gold-bearing veins of the stringer type which have broken down, the dust washing into the Piaxtla River bed. An engineer reporting to E. V. Eaton, American vice-consul at Mazatlan, states that the formation carrying these broken veins has been traced for a considerable distance. If the gold content is as high as at the point where the veins have broken at the river, recovery should total $500,000. Formations surrounding these veins appear to favor other finds, but to estimate the prospect of future developments is difficult.

Miners panning the deposit were reported to be averaging from five to eight "shines" of dust per pan, which, considering the size of the dust, would amount to about 5 pesos ($2.50) a day. So far as can be determined, no rich strikes were made, although great excitement was caused by the discovery and there have been wild rumors of fabulously rich finds. Newspapers printed stories of the discovery of great lumps of solid gold and reported that some miners were washing out as much as 10 kilos (22 lb.) of gold per day. A sober estimate places the amount taken out at $50,000 before operations were stopped by General Juan Dominguez, Jefe de Operaciones, at Mazatlan.

About 150 claims were denounced at Cosala by peons, but, as news of the discovery spread, politicians and men of some means filed other denouncements covering the same property at San Ignacia, the municipality in which the deposit is located. The result is that all operations have been ordered stopped, pending a decision from Mexico City as to whose denouncements will be considered valid. Unofficial reports are that General Plutarco Elias Calles, in Mexico City, has denounced a tract 22 km. square (13.67 miles), the largest denouncement ever filed in Mexico, if not in the world. The peons believe that General Calles made his denouncement to protect their claims from the group which filed denouncements at San Ignacio, as General Calles sent Licenciado Osuna, his secretary, to El Tambor to obtain their consent to represent them. Local opinion is that the last denouncement filed will be declared legal. In the meantime the Cosala and San Ignacio contingents have formed two armed camps, each jealously guarding the other to see that no dust is panned.

Under Mexican law, the party denouncing a mining claim has 60 days in which to have the claim surveyed and the surveyor's plan filed and made of record; otherwise the denouncements become null and void. General Dominguez received instructions from Mexico City, however, not to permit any claim to be surveyed. The General sent an escort out to El Tambor to bring into Mazatlan a mining engineer who was on the property at the time. No further attempts have been made to survey any of the claims.

Mohawk Starts Crosscutting on No. 15 Level at Michigan

Mohawk has entered the actual development stage in its Michigan mine property in Ontonagon County, Mich. A crosscut has been started in "E" shaft at the No. 15 level to cut the Butler and other lodes. All favorable veins will be investigated. The history of the Ontonagon mines would indicate that the Butler offers the most encouraging possibilities. Close selection is necessary in the Butler, but Mohawk has such an extensive area on the vein that only the best ground need be mined.

At the Mohawk mine, No. 6 shaft continues to disclose ore as good as the ground opened in the last few years. No. 1 is nearing the end of its productive career. The few remaining blocks of fair copper ore and portions of shaft and floor pillars are being removed. The shaft has been furnishing less than a quarter of the mine's production. With the closing of No. 1, Mohawk will have only No. 6.

A saving of 1.3 lb. of copper per ton of ore treated is being made by flotation in the stamp mill. About 55 per cent of the total ore stamped is put through flotation.

■

Quincy Mill Recovery High

Quincy has complete flotation units at four heads in the stamp mill, near Hancock, Mich., and losses have been reduced to less than 2 lb. of copper per ton of ore stamped. Production, which is about 1,000,000 lb. of copper per month, is being handled by a small reverberatory furnace at satisfactory cost, forecasting a low cost when production is increased sufficiently to start the large furnace and casting machine.

No. 8 shaft of the Quincy mine, which was holed through from the 86 level driven north from No. 6 shaft, has been timbered and completed to the 82 level. It has been stripped full width to the 86, and timbering will follow as rapidly as possible. Meanwhile good ground is being opened both north and south of the shaft. The miners recently completed the removal of a 15-ton mass of copper on the 82 level, south. Completion of the shaft to the 86 level will allow rapid expansion of operations to the north in the lower levels, with increased tonnage of copper rock. Curtailment of production is continuing, the number of men employed having been cut to the lowest possible minimum. The mine is operating five days a week and the mill four days.

■

One United Verde Furnace Down

One furnace has been closed down at the United Verde Copper smelter, Clarkdale, Ariz., as the result of a slide of waste rock at the open pit, near Jerome. An official statement, released early in April by W. V. DeCamp, manager, follows:

"The slide of waste rock, approximating several hundred thousands yards, from the walls of the pit at the United Verde mine, has materially interfered with ore production from the pit. Since the removal of this waste material from the pit will require a considerable period of time, the management has decided to discontinue immediately the operation of one of the two furnaces now operating. In the near future the second furnace will probably be discontinued until such time as normal conditions are again established in the pit. Even though both furnaces are discontinued, there will be little interruption of work at Jerome, since mining of underground pillar ores will continue, as well as the construction work on No. 7 shaft, and the pit work will be pushed as rapidly as possible."

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A.I.M.E. Anniversary Meeting at Wilkes-Barre, May 22

Sixty years ago, at Wilkes-Barre, Pa., the American Institute of Mining Engineers was founded, and on Friday, May 22, 1931, a one-day celebration of the event will take place in the same city. All A.I.M.E. members and their guests, ladies included, who may be within convenient traveling distance of the Pennsylvania city are invited to attend. The day will be taken up with inspections of the most interesting coal mines and washing plants, with a lunch at midday and a dinner in Wilkes-Barre in the evening. A meeting of the board of directors of the Institute is scheduled to precede the dinner, and a good attendance of prominent mining engineers seems assured.

Particular effort is being made to make the trip appeal to those whose interest is in fields of activity entirely distinct from coal mining; in fact, if one has never been in a coal mine, here is just the opportunity to learn all about the source of next winter's supply of anthracite. The New York section is featuring the Wilkes-Barre meeting as a special excursion, and arrangements are being made for sleepers leaving New York late Thursday night and returning to the city early Saturday morning, with the entire expense for rail and sleeper fare, plus expenses in Wilkes-Barre, at between $15 and $20 per person, depending upon the number going. Many will probably drive their automobiles and spend the two nights at one of the hotels. Philadelphia, Washington, and other Eastern points will also be represented at the meeting by groups of Institute members.

■

Accident Closes Falconbridge

Mining and smelting operations of Falconbridge Nickel Mines, near Sudbury, Ont., have been temporarily suspended as a result of an accident to one of the converter blowers, causing a complete shutdown of the plant. Added misfortune was caused by the fact that the mishap occurred at a time when a standby blower was away for repairs. The effect of the shutdown will be to interrupt production for a period of at least three weeks while material for repairs is obtained from Bridgeburg, N. Y. Meanwhile, the entire force will be retained on a basis of half-pay for the period of the shutdown. Advantage will be taken of the opportunity to carry out some necessary underground development work at the 350 and 1,000 levels, and to complete assessment work on the holdings of the company.

Falconbridge Nickel in the three months ended March 31 treated 26,624 short tons of ore, with matte output 2,148,569 lb., containing 314,031 lb. of copper and 1,269,510 lb. of nickel. This is the highest quarterly output of the company since production started early in 1930.

Low-Grade Results Obtained on 2,800 Level of Magma

Development work done during 1930 at the property of Magma Copper, near Superior, Ariz., centered on the 2,800 level, according to statements made by William Koerner, general manager, in the company's annual report. Although no estimate of the average grade opened up on this level is given, the vein material was generally of lower grade than that on the 2,550 level, on which development work centered in 1929. On that level, two main oreshoots were opened up. One was west and south of No. 5 shaft and the other was north and east, in the Magma vein.

During 1930, a drift driven west from No. 5 shaft showed the vein maintains its average width but is very low in mineral content at that depth. A raise is now being put up to connect the 2,800 with the 2,550 level and to prospect the vein between the two levels. To the east of No. 5 shaft, a drift was driven in the footwall of the Magma vein, which was cut 820 ft. north of the shaft. This drift connected with the footwall drift driven west along the vein from the No. 2 and No. 3 shaft workings. Six crosscuts to the vein were driven, showing ore of varying width and grade. In the western section of the drift, an oreshoot about 400 ft. long is indicated west of the main oreshoot. No ore was found in this section on the upper levels.

In the area east of the Nos. 2 and 3 shaft workings, development work was done on the 1,800, 2,000, and 2,550 levels. No. 24 winze, connecting the 2,000 and 2,550 levels, was completed. Drifts are now being driven east on the 2,000 and 2,550 levels that will eventually connect with the new No. 6 shaft. Sinking of the No. 6 shaft, at the extreme east end of the property, had reached a depth of 1,576 ft. at the end of the year. No. 7 shaft, at the extreme west end, was down to 2,444 ft. and has since been connected with the 2,550 level workings from No. 5 shaft. These two shafts—Nos. 6 and 7—are 8,350 ft. apart.

Average cost of producing copper, after local taxes, depreciation, and other fixed and general expenses, was 8.97c. a pound in 1930, compared with 9.987c. in 1929. Mill recovery in 1930 was 97.94 per cent of the copper content, compared with 98.31 per cent in 1929. Heads also were lower, averaging 6.46 per cent copper, compared with 7.05 per cent. Average grade of ore mined was 6.9 per cent in 1930, 7.62 per cent in 1929.

■

Miami Completes New Shaft

Miami Copper has finished sinking the new No. 6 incline shaft at its property at Miami, Ariz. This shaft has been put down to improve the existing ventilation system and will be of special benefit to the workings in the section of the orebody that will be served by the new 1,000 haulage level. The shaft is 1,160 ft. long, connecting with the top of a 209-ft. raise, put up at an incline of 50 deg. from the north side of the workings on the 620 level, now the main haulage level. To avoid sinking through ground that will be affected by caving operations, No. 6 shaft was put down at a 30 deg. angle, making possible the use of drifting methods. At the top of the shaft, a 100-hp. electric fan, with a capacity of 80,000 cu.ft. of vitiated air per minute, will be installed.

Utah Copper Costs Rise; Reserves Maintained

Operating costs, both per pound of copper and per ton of ore, were much higher at the Utah Copper property, at Bingham, Utah, in 1930 than in 1929, according to statements by D. D. Moffat, general manager, in the annual report. Ore reserves were maintained. Construction work was limited to additional electrification of the open-pit haulage system, additional housing accommodations for employees, and minor additions to the Magna concentrator.

Increase in mining, milling, and metal costs is due entirely to curtailment of operations and production, according to Mr. Moffat. After depreciation and all other charges, except federal taxes, the cost per pound of copper was 8.47c. in 1930, compared with 6.65c. in 1929 on the same basis. Total costs per ton of ore rose from 86.75c. in 1929 to 106.94c. in 1930.

Developments by churn drilling, aggregating 6,166 ft. for the year, indicate prospective extensions of the orebody and developed ore probably in excess of that mined during the year. These results, however, were not fully calculated into ore reserves, which are again given as about 640,000,000 short tons of ore, averaging 1.07 per cent copper, despite extraction of 9,552,500 tons during the year. There has been mined to date a total of 203,421,177 tons of all classes of copper ore. From the underground sulphide mine, shipments of lead-zinc-copper ore were limited to 22,828 tons in 1930, and operations are now entirely on a development basis.

■

Granby Reserves Up Slightly

Reserves of copper ore at the properties of Granby Consolidated on Dec. 31, 1930, were 14,601,149 short tons, compared with 14,341,970 tons at the end of 1929. This gain was registered despite extraction of 2,212,445 tons during the year. Most of the new ore was developed at the Allenby mine, at Copper Mountain, B. C. In spite of an extensive program of exploration at Anyox, B.C., no new orebodies of consequence have been found at the company's Hidden Creek mine there. About two-thirds of the company's reserves are now contained in the Allenby mine. Although the grade of reserves is not given in the annual report, the grade of milling ore in 1930 was 1.34 per cent copper at Allenby and 1.15 per cent at Anyox.

Rebuilding of the Bonanza bunkhouse at the Anyox unit, destroyed by the rock slide in November, has been virtually completed. No other construction is under way at this property, and Allenby is now shut down, pending improvement in the price of copper.

■

Mining Fellowships

The Montana State Bureau of Mines and Geology offers in the Montana School of Mines, fellowships in mining engineering, metallurgy, ore dressing, and geology. These fellowships carry a stipend of $750 for ten months, and the holder will be expected to devote half his time to research in his chosen field and the other half of his time to graduate study in cognate fields with a view to candidacy for the master's degree. Candidates should have received a bachelor's degree in engineering or physical science from a reputable institution, and should submit a transcript of their college record, the names of three references, and a recent photograph of themselves to the head of the department concerned, Montana School of Mines, Butte, Mont.

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N. J. Zinc in Patent Dispute

New Jersey Zinc has filed suit in the U. S. district court against J. A. Singmaster, former general manager of its mechanical department, and the Tubize Chatillon Corporation, to compel assignment of a patent issued in August, 1929, to Mr. Singmaster for an improvement in artificial silk filaments. New Jersey Zinc claims that the process covered by the patent was invented while Mr. Singmaster was in its employ and that he was under contract to disclose and assign all patentable ideas to it.

■

Propose Mine Timber Study

A thorough study of mine timber will be made by the American Mining Congress to determine the most economical size, the most serviceable species, and the most suitable grade, either treated or untreated, to meet the various requirements of the mining industry. The investigation will be carried on by the mine timber committee of the national standardization division of the American Mining Congress under the chairmanship of Reamy Joyce, of Chicago, vice-president of the Joyce-Watkins Company, a specialist in timber for mine, railroad, and other industrial uses and in wood-preservation methods. Mr. Joyce is organizing subcommittees on a geographical grouping to study and recommend methods for application to all the mining fields of the country. He will also organize a service records committee that will function for the mining industry in a manner analogous to the services afforded in their respective fields by the American Railway Engineering Association and the American Wood Preservers' Association.

■

Survey of Alaskan Resources

A special appropriation of $250,000, made by Congress during its recent session, will be used this summer to investigate the mineral and other resources of Alaska along the Alaska Railroad. This is in addition to the regular appropriation for Alaskan work. Although this appropriation is not available until July 1, the U. S. Geological Survey has arranged to make advances from its own fund so that the work may be started earlier in the season. Among the areas on which particular attention will be focused will be the Willow Creek, Fairbanks, Copper Mountain, Girdwood, Kantishna, Moose Pass, Valdez Creek, Chulitna, Talkeetna Mountains, and Yentna districts, known to contain non-ferrous metal deposits. In addition, investigation of non-metallic minerals along the railroad will be made. The Anthracite Ridge coal fields will be drilled.

California Compensation Costs Discussed at Meeting

That the high rates of compensation insurance in California, which is one of the obstacles to increased gold production from that state, are the result partly of high accident rates was brought out at the San Francisco section meeting of the A.I.M.E. on April 14. F. L. Lowell, chief mining engineer of the Industrial Accident Commission, described safety practices applicable to California mines. Mr. Lowell reviewed accident statistics and indicated the relatively large proportion of accidents in California mines. He pointed out the need for greater attention to safety practices.

Frank J. Creede, of the State Compensation Insurance Fund, explained the workings of the state accident insurance fund and the method of determining rates. According to Mr. Creede, 40.6 per cent of insurance premiums is for overhead and expenses and 59.4 for the payment of losses. As the cost of administering the state insurance fund is about 15 per cent, the difference between 40.6 and 15 per cent is returned as dividends to those who insure under the state fund. Commenting upon the high rate of $10.54 per $100 of payroll, he showed how this was the result of more liberal provisions of the California law and the existing high accident rate. He pointed out that some of the self-insured mines had, by consistent development of safety practices, reduced their rates to $3 per $100 of payroll. Inspection, he said, will help, but it will not solve the problem. Lower rates can be secured only by better safety work.

In the discussion, P. R. Bradley pointed out that the key to the situation is management and that when the men know that the management is directly committed to a policy of safe operation, good results will follow. He stated that although Alaskan payments to the injured were heavier than in California, the Alaska Juneau property had reduced its compensation expense to $2.75 per $100 of payroll by a consistent safety policy.

■

Contract for Santa Rosa Ore

A contract has been signed to supply 100 tons of lead ore daily, or 3,000 tons a month, by Joseph Le Cyr, operating the Santa Rosa mine, near Keeler, Inyo County, Calif., to U. S. Smelting, Refining & Mining, according to M. W. Woolley, Western field agent for the smelting company. The ore will be shipped to the company's smelter at Midvale, Utah, and the contract is said to provide for five years at the specified rate of shipment.

The Santa Rosa mine, which is in the same district as the Cerro Gordo and Estelle properties, now operated by American Smelting & Refining, was at one time under option to U. S. Smelting. The option was abandoned when work performed failed to develop the expected oreshoots. Mr. Le Cyr then obtained a lease on the property and continued development. A 110-ft. winze was put down from the 275 level of the mine and cut ore 8 ft. wide and said to average 45 per cent lead, 3½ per cent copper, 90 oz. of silver, and $1.50 in gold per ton. Shipments from the A. S. & R. mines have averaged as high as 50 per cent lead. Mr. Le Cyr has put down another shaft on North Hill to a depth of 350 ft. and is said to have opened a second oreshoot.

BRIEF NOTES

American Metal Company of New Mexico. At the company's Pecos mine, at Tererro, N. M., on April 11, the company completed 72 consecutive days in the mine and 57 days in all the departments without a lost-time accident, according to C. E. Wheelock. The average number of employees was 580 daily. Pecos produces and concentrates zinc-lead-silver ore.

Bonanza Mining. Shipments are being made from the lease in Park Bingham ground at Bingham, Utah, at the rate of 30 carloads of ore monthly. The ore assays 17 per cent lead, 6 oz. of silver, and $1 in gold to the ton. The company is also developing its ground at Yucca Grove, Calif., where it owns a half interest in the Death Valley Gold property. Two prospecting shafts are being put down on quartz veins.

Braden Copper. Ore reserves at the property, Sewell, Chile, were about 230,750,000 short tons of ore, averaging 2.18 per cent copper, on Dec. 31, 1930. This represents deduction of the 3,943,775 tons mined during 1930 from the estimate at the end of 1929, as no new calculation was made. Grade of ore handled in 1930 was about the same as in 1929, but the recovery in the metallurgical plants was better. The mill recovered 88.12 per cent and the smelter, 97.67 per cent, of the copper content, compared with 86.61 per cent and 97.07 per cent in 1929. Actual copper production dropped from 176,325,895 lb. to 161,986,598 lb.

Broken Hill South. Following the lead of Zinc Corporation, Broken Hill South, one of the three foremost mining companies at Broken Hill, New South Wales, Australia, has given the Barrier Industrial Council a two months' notice of intention to suspend operations. Whether the mine will actually suspend work depends in large part on the future course of metal prices. North Broken Hill, third of the large Broken Hill companies, has not yet given notice, and C. J. Emery, general manager, is quoted as saying he hopes the necessity will not arise.

Butte & Superior. Ore reserves at the property at Butte, Mont., were 288,875 short tons, assaying 15.35 per cent zinc and 5.68 oz. of silver to the ton on Dec. 31, 1930. This is an increase of more than 100,000 tons over the reserves at the end of 1929 and results largely from the continuation of development after regular production was suspended. This does not include 98,946 tons remaining in the old upper level orebodies. However, the reserves are largely nominal, as the company has dismantled all equipment, in preparation for permanent abandonment.

Calumet & Arizona Mining. Excavation has been started at the Douglas smelter in Arizona for the new reverberatory furnace. Its inside dimensions will be 26x106 ft. and it will have a capacity of 1,000 tons of charge daily. It will be equipped with fixtures for burning natural gas, which is being piped into the district from Texas. The cost of equipping the entire smelter to use natural gas as fuel is expected to be about $50,000 to $75,000.

Como Mines. Resumption of operations at the silver-gold property of the company, Lyon County, Nev., is planned. The property comprises 36 claims, about 10 miles southeast of the Comstock Lode. Work was suspended several months ago, after retimbering and enlarging the Boyle tunnel for 3,500 ft. The development program consists of extending the tunnel in two directions toward the Como and Rapidan veins. Modern electrified equipment has been installed at the Boyle tunnel. R. M. Atwater, Jr., is consulting engineer of the company.

Dawes Gold Mines. This company, which now owns the discovery claims in the new Scossa gold field of Nevada, is sacking high-grade ore, according to E. M. Dawes, president of the company. Sinking of No. 2 shaft, which is being put down on lower-grade material, will be continued until a depth of 100 ft. is reached. It is now down about 65 ft. A drift will then be driven to the position of the discovery shaft, about 70 ft. away. Two leases on the property are said to be shipping some high-grade ore.

Eagle Bird Mine, Inc. Development of the Eagle Bird vein, and all other known veins on the property, 18 miles northeast of Nevada City, will be continued laterally and at depth—the deepest level now being at 450 ft. A 50-ton mill is in operation on ore carrying 75 per cent of its gold content as free milling gold and 25 per cent associated with pyrite and galena. G. G. Thomas, general manager of Bagdad Copper, is also general manager of this property. J. W. Still is consulting engineer and Clayton Chatfield, mine superintendent.

El Oro Mining & Milling. The first shipment of bullion has been made from the company's mill at the Allison mine, near Tucson, Ariz. It consisted of 428 oz. of gold-silver bullion, valued at $2,945, and was sent to the San Francisco mint. In addition, the company produces gold concentrate, valued at $400 a ton, which will be sent to the Hayden smelter of American Smelting & Refining. To increase production, a second ten-stamp unit will be added to the mill. Eventually, an entirely new plant, with a capacity of 300 tons daily, may be built. About 45 men are employed.

International Nickel. Plans have been completed and a contract has been awarded to the Canadian Westinghouse Electric for installation of a three-transformer single-phase substation at Copper Cliff, Ont. The substation will be installed for the purpose of receiving the company's share of the 100,000 hp. of electric energy contracted for with the Ontario Hydro-Electric Power Commission from the Abitibi River hydroelectric development. The expenditure involved, it is understood, is about $200,000.

Kildun Mining. A telegram from the property, in the Matehuala district, San Luis Potosi, Mexico, states that the main vein has been cut on the 1,475 level. It is 10 ft. wide where cut and is said to sample about 42 oz. in silver and $4 in gold to the ton. This is the first crosscut driven in the sulphide zone. A description of development being done at this property was published on p. 288 of the March 23 issue.

Lewiston Dredging. The company, which operates a gold dredge on the Trinity River, above Lewiston, Calif., is reported to have purchased 120 acres of additional placer ground near the junction of Stewart Fork and Trinity River. The dredge will be moved up the river after the present area has been exhausted.

Mutual Mines. The company's new 100-ton lead-silver mill was put on a two-shift basis at the property in the Coeur d'Alene district on April 15. Operation of the plant was started on April 9. The mill supply is now coming from the main tunnel level, west of the shaft, but preparations are being made for stoping ore on the 150 level as well.

Nipissing Mining. Concerning the property at Cobalt, Ont., the immediate future is in doubt, according to Hugh Park, general manager. The drop in the price of silver has wiped out profits, and, although output was maintained in 1930 at the expense of treating higher-grade ore, reserves were depleted. The cost of producing silver dropped from 37.812c. in 1929 to 36.130c. per ounce in 1930. Development opened some high-grade ore, and there is, in addition, a reserve in residue dumps and in several veins underground of material containing cobalt and silver that is available for future shipment. At the company's property at Nisto Lake, Saskatchewan, drilling indicated a large, low-grade sulphide deposit of no present value.

North Lily. Connection of the company's shaft, near Dividend, Utah, with the Big Hill shaft of its subsidiary, North Lily-Knight, is expected to be completed about May 5. Following completion of this work, sinking of the Big Hill shaft from the 1,700 level will be resumed. Water will be pumped from the Big Hill shaft to two settling tanks, of 20,000- and 40,000-gal. capacity, on the 1,600 level and on this horizon to the 1,200 level of the North Lily. Connection of the two mines makes unnecessary expense of installing pumping equipment at the Big Hill shaft during the company's program of exploration there. It also provides improved ventilation and safety facilities.

Silver Summit. The Sunshine silver vein has been cut on the company's property, in the Coeur d'Alene district, Idaho, at a vertical depth of 1,040 ft. and about 3,000 ft. east of the Sunshine boundary. Lateral development of the vein, which was 8 ft. wide where cut and which showed low-grade mineralization, is now under way. A drift is being driven east in the footwall, and crosscuts will be put through the vein at regular intervals. To cut the vein, Silver Summit drove a tunnel south 4,300 ft., crosscut west 900 ft., and then drifted southwest along a showing of quartz and siderite. Harry Pearson is superintendent of the mine.

South African Copper. Having completed development of "sufficient ore reserves and an adequate water supply to justify equipment," the company purchased the Cape Copper property, in the Namaqualand district of Cape Province, Union of South Africa. Owing to the depression in the copper business, it was possible to complete this purchase at a substantial discount from the option price. According to C. F. Ayer, president of Newmont Mining, which has a 51 per cent interest in the property,

(Continued on page 388)

EXCLUSIVE

CABLES

FROM CORRESPONDENTS IN THE PRINCIPAL MINING CENTERS

Rio Tinto Holdings Criticized; Panama Issue Approved

London, April 21.—At the annual meeting of Rio Tinto, probably the most important of the British-controlled copper and sulphur producers, adverse criticism was voiced to the company's investments in Davison Chemical, Silica Gel, Minerals Separation, and Northern Rhodesian copper properties—particularly in regard to the latter. The company was recently forced to issue £2,000,000 in 5 per cent redeemable debenture stock to insure its holdings in Rhodesian stocks. Certain of the critics pointed out that the value of the company's holdings had actually dropped 60 per cent—not 35 per cent, as shown in the accounts. A further shrinkage in the company's revenue, which was £686,966 in 1930 and £1,286,279 in 1929, was considered certain in 1931, in consideration of the present low prices of commodities. Rio Tinto shares have dropped to the lowest levels in recent years, being quoted at £22⅝ today, compared with a high of £66⅛ in 1929.

. . . . At the adjourned extraordinary general meeting of Panama Corporation, held on April 17, the company increased its capital by 2,500,000 shares of £1 par to £4,500,000. An issue of £250,000 in 8 per cent debentures is now being made, and a further issue of £150,000 will be put out at the end of the year. A total debenture issue of £1,000,000 has been authorized. The British, Foreign & Colonial Corporation, which is underwriting the issue, has an option to take at par the balance of £600,000 in blocks of £200,000 at any time within two months after auditors certify that six months of operation has yielded sufficient profit to cover debenture interest three times. All debentures will be convertible into shares at par within five years. Hugh Marriott, director, reported excellent developments. Production is expected to start within a short time at the Remance mine, as all the machinery has arrived. The Panamanian government has expressed its gratification at the progress of the company. A recent shipment of 9 tons of selected Remance ore yielded 98 oz. of gold and 72 oz. of silver.

. . . . Wiluna Gold reports that in March, 14,000 long tons of ore was treated, averaging 32s. per ton, and that successful operation of the metallurgical process is indicated. Representative results are not expected for some time, owing to absorption of gold content by the equipment and to necessary minor adjustments.

. . . . Pahang Tin, Malayan tin-dredging enterprise, is petitioning for exemption from the tin-quota agreement, recently adopted by the Federated Malay States, to restrict exports of the metal. If the company fails to obtain exemption, indemnification will be sought from the State of Pahang. Results will be watched with interest.

Robinson Deep Plans Carrying Operations to 8,500 Ft.

Johannesburg, April 22.—Robinson Deep, which already boasts the world's deepest mine workings, plans to carry its operations to an eventual depth of 8,500 ft. vertically below the surface of its property on the Witwatersrand. This fact was announced at the company's anual meeting. The Village Deep shaft, which the company acquired by merger last year, is now 7,640 ft. deep. The Robinson workings, prior to the merger, were down only about 6,000 ft., but since then the Village Deep levels have been extended into Robinson ground. Profits are now on the basis of £25,000 monthly, which had been expected as a result of the merger, and the tonnage handled is about 100,000 short tons monthly. Grade, in February, at 25/- in gold per ton compares favorably with the 1930 average of 23/2.

. . . . Grade of ore at the Modderfontein East mine has been improving. In 1930 it averaged about 25/3 and in January it was down to 25/- per ton in gold. February saw the average rise to 25/7, and since then there has been further improvement. The improvement is due almost entirely to more selective mining rather than to an actual increase in the grade of ore developed.

. . . . The success of Daggafontein Mines in its development program on the Far East Rand has centered attention on the area lying between its property and that of Sub Nigel, at Heidelberg, to the south. Union Corporation has arranged a contract for prospecting the farm Vlakfontein, in the Heidelberg district. Leasing of several other areas is understood to be imminent under the auspices of leading Rand groups and in conjunction with the government. In fact there are evidences of great activity in prospecting for gold all over Transvaal, Southern Rhodesia, and the northern section of Orange Free State.

. . . . In the Selukwe district, of Southern Rhodesia, the Walrus mine is developing well. A prospecting syndicate is endeavoring to locate the extension of the Wanderer lodes. The Wanderer property has been doing well, the costs being surprisingly low in view of the comparatively small scale of operations—between 14/- and 15/- a ton. Production is being maintained at about 15,000 short tons monthly. In the Que Que district of Rhodesia, several properties have recently been optioned by Johannesburg mining-finance concerns.

. . . . A geophysical survey of copper deposits in Northern Transvaal is reported to have yielded encouraging results. At present the only large producer in that section is the Messina mine, producing 750 long tons of refined copper monthly.

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Brief Notes

(Continued from Page 387)

electrolytic copper can be produced and delivered to New York or London for 8c. a pound. However, this property will probably not be brought into production until a better copper situation exists.

Tennessee Copper. Operations at the property in 1930 were on a reduced scale from the record tonnage of 1929, J. N. Houser states. The Burra Burra and Eureka mines were operated, and development of the Polk County mine, started in 1929, was continued with encouraging results. The major underground development work during the year was the sinking of the McPherson shaft from the No. 18 to the No. 20 level. Ore reserves on Jan. 1, 1931, were estimated at 6,034,148 short tons, an increase of 254,589 tons for the year. Gratifying reductions in cost and improvements in operations and metallurgy were realized.

Treadwell Yukon. The company has taken over the old Commonwealth property, 15 miles southeast of Reno, Nev., and previously owned by Washoe Consolidated Mining & Milling. About 50 years ago, the Commonwealth mine was the center of activities of the town of Galena. Shipments of ore, according to records, included 42 carloads that yielded from $350 to more than $1,000 a ton. When the sulphide zone was reached, however, presence of zinc made treatment of the ore at the time difficult. In 1929, Treadwell Yukon optioned the mine, but later abandoned it because only one patented claim and a mill site were included in the property. Since then, Treadwell Yukon has acquired eight adjoining claims. Washoe Consolidated, controlled by C. N. Miller, of San Francisco, and Judge W. P. Seeds, of Reno, has owned the Commonwealth mine for the last twenty years.

Trepca Mines. This new Jugoslavian lead-zinc producer cut a total of 223 ft. of ore in its new deep adit. The ore averaged 13.7 per cent lead and 7.9 per cent zinc, of which the last 98 ft. averaged 24 per cent lead and 4.6 per cent zinc. The ore was cut at a distance of more than 2,500 m. from the portal of the adit and at a depth considerably below the other workings. In March, Trepca treated 22,215 tons of ore and produced 3,549 tons of lead concentrate averaging 79 per cent lead and 2,421 tons of zinc concentrate averaging 51.6 per cent zinc. The grade of concentrate has been improving steadily. Originally designed for 500 tons daily, the Trepca concentrator has been averaging well over 700 tons.

MARKET AND FINANCIAL NEWS

Tariff Commission to Push Copper Costs Study

I. D. Foos
Washington Correspondent

Investigation of foreign and domestic costs of copper production during the past three years is the most pretentious that the reorganized Tariff Commission has undertaken to date. As the Commission is planning to submit its report to the Senate next December, no time will be lost in obtaining the necessary data. Such data, said the Commission, will be sufficient to inform the Senate concerning the advisability of a tariff on copper, but the Commission will not make any recommendations with respect to the need for duty or the possible rate of duty. In commenting on this aspect of the matter, Commissioner Coulter stated that the question of the advisability of the tariff on copper is one of policy that only Congress can determine. Only Congress can decide, he said, whether domestic high-cost copper reserves should be conserved or be utilized.

Judging by the cost schedule that will be used by the Commission in this investigation, its report to the Senate in response to the resolution sponsored jointly by Senators Hayden, of Arizona; Wheeler, of Montana; and Vandenberg, of Michigan, will be of a more or less intricate character. Whether or not a tariff on copper is warranted on the basis of comparative and foreign costs will not be apparent on the face of the report, as it will embrace such factors as operating and development expenses, depletion or royalty, depreciation, general and administrative expenses, transportation costs, and value of fixed assets for the computation of interest on investment. Cost data on production, to be supported by evidence of purchases, sales and inventories, will include adjustments on account of joint products and byproducts.

An examination of the annual reports of representative companies has shown to the Commission that these are not generally sufficient for an accurate determination of the cost of copper, because much of the metal leaving the mines, mills, smelter, or other producing plants, both foreign and domestic, has not been bought or sold at open market prices, but has moved by inter-company transfers. Such transactions, in the Commission's opinion, are not necessarily, or perhaps usually, an adequate measure of cost.

The Commission's agents will be sent wherever it may be necessary to obtain essential data. If foreign costs cannot be established as a result of the examination of the record of offices maintained in the United States, the agents will go to the headquarters and to producing districts in foreign countries.

The investigation will embrace the products of (1) the mine and the concentrator; (2) the smelter and the leaching plant; (3) the converter, the electrolytic plant, and the refinery, and (4) scrap. The relative importance of these groups cannot be shown by figures of production, because, according to the Commission, separate statistics of production are not compiled, and for the additional reason that any possible compilation would involve continuous duplication of the same product carried through successive stages of reduction.

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Domestic Lead Stocks Up 7,600 Tons in March

Domestic production of refined lead during March was at a lower rate than in the preceding month, but with no important change in the actual movement of metal into consumptive channels, stocks increased to the extent of 7,600 tons. Stocks of refined lead in the hands of United States refiners on the last day of March totaled 130,426 tons, according to the American Bureau of Metal Statistics, against 122,826 tons a month previous, and 42,469 tons in March a year ago.

Production of lead from domestic ore during March was at the daily rate of 1,348 tons, against 1,409 tons in February, and an average of 1,686 tons for the whole of 1930. The daily rate for March, 1930, was 1,824 tons.

United States Lead Statistics

Production	Jan.	Feb.	Mar.
From domestic ore	43,405	39,464	41,775
Secondary and foreign	3,892	4,654	2,675
Totals	47,297	44,118	44,450
Stock at beginning (a)	103,247	113,145	122,826
Total supply	150,544	157,263	167,276
Stocks at end (a)	113,145	122,826	130,426
Shipments by difference	37,399	34,437	36,850
Shipments reported	37,633	34,439	36,411

(a) Domestic only.
The United States lead refinery statistics account for refineries at Omaha, Selby, Perth Amboy, Carteret, Collinsville, East Chicago, Herculaneum, Grasselli, Federal, Kellogg, Galena, Newark, Matawan, Indianapolis, Joplin, and Ontario.

Kennecott Income in 1930 One-Third of 1929 Total

In 1930 Kennecott Copper Corporation and its subsidiary companies earned $15,890,152, after depreciation, compared with $52,756,468 in 1929. These figures are before deduction of minority interest in income of subsidiaries. The company's metal output in 1930 was valued at $72,211,267, and additional revenue of $5,347,922 was obtained from operation of its railroads, steamships, and wharf. Net operating profit was $20,746,366 in 1930 ($54,790,190 in 1929). The company received $3,920,522 in interest, dividends, and from miscellaneous sources. Production of copper in 1930 was 346,115,719 lb., of which 161,986,598 lb. came from the Braden property, in Chile; 161,138,717 lb. from the Utah Copper property, in Utah; and 22,990,400 lb. from the Alaskan operations, of which the Latouche mine has now been closed. In 1929, copper production was 501,134,000 lb.

On Dec. 31, 1930, the balance sheet indicates, total Kennecott assets were $308,556,397 ($337,307,866 at the end of 1929). Current assets were $56,923,643, including $18,274,895 in metals on hand and in transit. Current liabilities were $4,267,431. The company has investments of $27,555,371 in partly owned, allied, and affiliated corporations. The only bonded indebtedness shown in the balance sheet is $2,455,000 in 5 per cent serial bonds, due 1940, of Chase Brass & Copper, the manufacturing subsidiary. Earned surplus on Dec. 31 was $132,117,468, compared with $131,939,920 at the end of 1929.

■

N. Y. & Honduras Rosario

Profit for year 1930 carried to surplus, after deductions for depletion and taxation, was $443,449, according to the annual report of New York & Honduras Rosario Mining. In 1929, it was $547,294. Gross value of 1930 production was $1,315,821 and operating profit was $441,319. The actual volume of production increased, although profits were lower, 2,957,120 oz. of silver and 13,498 oz. of gold being recovered. The balance sheet on Dec. 31, 1930, showed total assets of $4,341,320; current assets of $2,764,303; a surplus of $2,003,773; and current liabilities of $84,882. Surplus at the close of 1929 was $1,991,044.

Stocks of Copper Reduced 13,837 Tons in March

The March copper statistics revealed a reduction of 13,837 tons in combined stocks of blister and refined in the hands of North and South American producers. The decline in blister stocks during the month amounted to 4,413 tons, and refined stocks were down 9,424 tons. Production of refined copper was at the rate of 3,292 tons daily, against 3,566 tons in February, and 3,305 tons in January. United States mine output also registered a decline.

The decline in combined stocks reported for March was the fifth since last October and brings the total to 553,016 tons, against 605,075 tons last October, the peak month.

Summary of Copper Statistics
In Tons of 2,000 Pounds

Production:	February	March
Mines, United States	47,504	48,543
Blister, North America (a)	68,786	71,244
Blister, South America (a)	24,124	24,748
Refined, No. & So. America	99,853	102,058
World, blister basis	128,685	.....
Stocks (end of month): No. and So. America:		
Blister (b)	203,224	198,811
Refined	363,629	354,205
Totals	566,853	553,016
Great Britain (c)		
Refined	8,699	9,887
Other forms	1,784	1,723
Totals	10,483	11,610
Havre	3,785	6,393

(a) Includes direct-cathode copper. (b) Includes in process. (c) Official warehouses only.

U. S. Mine Production

	February	March
Porphyry mines	18,332	18,575
Lake mines	4,500	4,531
Vein mines	21,372	22,037
Custom c. se	3,300	(a)3,400
Total crude production	47,504	48,543
Daily rate	1,697	1,566

(a) Partly estimated

Smelter Production

	February	March
United States	55,229	57,922
Canada	9,408	9,228
Mexico	4,149	4,094
Totals	68,786	71,244

Shipments during March totaled 111,482 tons, of which 74,685 tons were domestic and 36,797 tons export. Total shipments in February were 100,051 tons, of which 60,636 tons were domestic and 39,415 tons export.

■

Announce Financial Details of Chilean Nitrate Deal

Under the terms of reorganization of Anglo-Chilean Consolidated Nitrate, by which it will be merged with Compañía de Salitre de Chile (the new nitrate combine known as Cosach), shareholders of Anglo-Chilean will receive four shares of Cosach in exchange for each share of their present holdings.

Cosach will have an authorized capital of 3,000,000,000 gold pesos (equal to about $365,000,000) divided into 15,000,000 Series A shares and 15,000,000 Series B shares, each of par value of 100 pesos, or $12.17. All the Series A shares are common and have been issued to the Chilean government in return for government-owned nitrate deposits up to 150,000,000 tons of recoverable nitrates and for concessions on export taxes. The Series B shares may be either common or preferred, with the number of preferred limited to 5,000,000 shares. Series B shares will be issued in exchange for assets of the various nitrate-producing companies.

Anglo-Chilean will receive a total of 8,318,335 shares of Series B common, of which 3,418,335 shares are in exchange for 2,441,668 shares of Lautaro Nitrate and 4,900,000 shares for assets of Anglo-Chilean. Of the 8,318,335 shares, 7,027,000 shares are to be distributed to holders of the 1,756,750 shares of Anglo-Chilean. The remaining 1,291,335 shares will be retained in the treasury against liquidation of certain accounts payable not transferred in the reorganization. Application will be made to list the Cosach Series B shares on the New York Stock Exchange.

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Butte & Superior Mining

In 1930, Butte & Superior recorded a net loss of $243,826, compared with a loss of $5,983 in 1929. Operating loss was $255,449 on a production of copper and zinc ore valued at $526,688. Ore shipments in 1930, previous to closing of the mine, were 79,242 short tons of zinc ore and 729 tons of copper ore. At the close of the year, current assets showed an excess over current liabilities of $584,065, compared with $896,172 at the beginning of the year. The company's total assets on Dec. 31, 1930, were valued at $6,590,465. D. C. Jackling, president, in his statement pointed out that distributions to shareholders by the company have been $69.87 a share on present outstanding stock, which has a par value of $10. Equipment is being dismantled, as the ore is virtually exhausted.

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Mohawk Mining Earnings

Net profit of Mohawk Mining in 1930, after depletion and depreciation charges, was $432,126, compared with $1,348,285 in 1929. Sales of copper in 1930 were only 7,151,328 lb. at an average price of 14.69c. a pound, and the operating profit was $599,293. Because of smaller sales, value of copper on hand at the end of the year—including metal contained in stored concentrate—was $1,269,246, compared with $741,523 on hand at the beginning of the year. The company's balance sheet shows total assets of $17,511,381 at the close of the year, of which $3,780,007 was current assets. Surplus on Dec. 31, 1930, was $2,625,325, compared with $2,653,136 on Dec. 31, 1929. Current liabilities were $89,431.

Utah Copper Reports Profit of $6,500,000 in 1930

Net income to surplus account of Utah Copper in 1930 was $8,889,381, or slightly more than a quarter of the 1929 income of $33,660,379, according to the annual report of the company. These figures are after deduction of depreciation charges, but before depletion. The 1930 report shows no allowance for federal income taxes in the operating statement, although it was included in 1929. D. C. Jackling, president, states that surplus tax reserves brought forward from 1929 covered this requirement. Operating revenue in 1930 (by which is meant value of all metals produced at the company's average sales price) was $20,069,585, compared with $52,563,219. Operating profit in 1930 was $6,501,452. Production in 1930 was 161,138,717 lb. of copper, 64,240 oz. of gold, and 563,330 oz. of silver; 1929 output was 296,625,554 lb. of copper; 116,087 oz. of gold; and 1,050,075 oz. of silver.

The Utah balance sheet on Dec. 31, 1930, showed $84,921,055 in assets, compared with $97,980,324 at the close of 1929. Assets included $3,211,072 in cash, $4,467,839 in marketable securities, $9,293,597 in copper on hand, $1,043,949 in accounts receivable, and $29,576,794 in investments. Accounts payable on Dec. 31, 1930, totaled $1,165,481. The surplus from operations was $55,796,366, compared with $68,344,036 at the close of 1929. The decrease was the result of adjustments in the value of metal on hand and of the excess of dividend payments over net income.

■

Treadwell Yukon Reports Loss

Treadwell Yukon, which operates non-ferrous metal mining properties in Canada and the United States, reports a deficit, after all charges, of $1,317,664 in 1930, compared with $297,362 in 1929. Of the operating properties, Wernecke mines reports a net loss, after depletion, depreciation, and taxes, of $43,637. Nevada mines, chiefly the Tybo property, reports a net loss, after similar charges, of $358,584. Wernecke made an operating profit, on a production of $1,771,933, of $224,377. Tybo made an operating profit, on a production of $833,073, of $44,558. The consolidated loss from operating properties was thus $402,221, to which must be added the expense of development work at the company's other properties, interest charges on loans, and general administrative expenses. At the end of the year the company's deficit totaled $1,906,265, compared with $608,972 deficit at the beginning. The company's indebtedness is now $8,137,300, bearing 7 per cent interest. Total assets, largely property and plant and equipment, were $7,829,272 on Dec. 31, 1930.

Cerro de Pasco Copper Loss $2,986,836 in 1930

In 1930, Cerro de Pasco Copper recorded a loss of $2,986,836, after deduction of depreciation and depletion charges, compared with a net profit of $4,729,113 in 1929. An operating profit of $3,248,755 was recorded in 1930, compared with an operating profit of $10,253,741 in 1929. Sales of metals in 1930 totaled $19,679,809 ($28,656,394 in 1929). Production figures are not included in the report. At the close of 1930, the company had a metal inventory of $3,464,964 (copper being valued at 10c. a pound and silver at 27.08c. an ounce). At the close of 1929, the company's inventory was $6,006,350 (copper being valued at 14c., silver at 43c.).

The Cerro de Pasco balance sheet on Dec. 31, 1930, showed total assets of $51,720,600, of which $23,648,442 was current assets. This included $9,500,000 in treasury notes, $1,663,718 in cash, and $3,163,358 in accounts receivable. Current liabilities were $1,545,091. Investments on Dec. 31, 1930, were valued at $1,812,539. The company's property was valued at $26,223,641, after deduction of all depreciation and depletion reserves. Gross value was put at $91,904,442. The consolidated surplus account, after deduction of capital surplus, was $4,841,870, compared with $7,380,241 at the close of 1929.

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Mining Corporation Report

Operating profit realized by Mining Corporation of Canada in 1930 was $91,322 in 1930, compared with $85,819 in 1929. The increase is due largely to the larger tonnage of cobalt ore handled in 1930. The company wrote off $2,425,023 in the value of its holdings in other companies and properties in 1930, and also $3,650,000 in the value of its mining rights. As a result, total assets on Dec. 31, 1930, were valued at $2,389,487, compared with $8,619,399 at the end of 1929. The company's assets include $62,430 in cash, $92,161 in ore in transit and on hand, $295,326 in secured loans, $96,571 in accounts receivable, and $1,199,714 in shares in other companies, at or below market value. Accounts payable were $57,250, and balances due subsidiary companies, $27,544.

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St. John del Rey Profits Up

After payment of London expenses and directors' fees, St. John del Rey reports a balance of £124,422 on operations during 1930, compared with £103,774 in 1929. Operating profit at the mine in 1930 was £136,644. A total of £40,000 was transferred to the capital works account, making the net profit £84,422 after the equivalent of depreciation. In 1929, £30,000 was transferred. Gross value of 1930 production was £525,209, almost entirely in gold. On Dec. 31, 1930, the balance sheet showed total assets of £2,113,793, of which £237,923 was in investments, £63,401 in cash, £32,352 in metals, and £11,175 in accounts receivable. Current liabilities total £74,033. After payment of 20 per cent dividends on preferred stock and 2/6 per share on common stock, the company had a balance of £41,369 at the close of the year, compared with £43,366 at the end of 1929.

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New Agreement Made for Sale of Industrial Diamonds

Arrangements have been made whereby L. M. Van Moppes & Sons, of Gardiner House, 10/14 Charterhouse St., London, England, will in the future direct the sales of all industrial diamonds controlled by the Diamond Corporation. The latter company, which was recently formed to unite the interests of the Diamond Syndicate and the diamond producers, has sold certain stocks of diamonds to a new company, called International Diamonds, Ltd., together with all rights covering the future handling of these qualities. International Diamonds, in turn, has arranged for their sale with Van Moppes.

The Diamond Corporation and its various interests control at least 90 per cent of the world's diamond production. This agreement therefore insures to L. M. Van Moppes & Sons a plentiful supply of industrial diamonds of all classifications. An official statement is to the effect that the control of sales has been arranged to better trade conditions and to bring prices of industrial diamonds into a co-ordinate relation with production costs. Further, assurance is given that prices will not be increased to uneconomic levels. No increase in the prices of industrial diamonds is therefore probable.

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Walker Mining Profits Down

Net income, after depreciation and taxes, earned by Walker Mining in 1930 was $276,232, compared with $830,863 earned by the same company in 1929. Although actual volume of production was higher, sales of ore and concentrates netted only $1,921,355, compared with $2,551,110 in the previous year. Operating profit in 1930 was $356,110. Copper production was 15,776,171 lb., gold, 16,899 oz., and silver, 377,994 oz. The balance sheet on Dec. 31, 1930, showed total assets of $3,562,765, of which $806,926 was current assets. Current liabilities were $64,855. The surplus at the end of the year was $876,775, compared with $731,742 at the beginning.

Newmont Mining Net for 1930 Shows Big Reduction

Newmont Mining made a net profit of $2,332,770 in 1930, after federal taxes, compared with $11,777,049 in 1929. The decrease was caused in large measure by a drop in profits from trading in securities, an item which is listed in the company's profit-and-loss statement under "other profits realized." In 1929, this item was shown as $10,177,535; in 1930 it dropped to $387,785. The company nevertheless showed an increase in its earned surplus from $35,781,922 at the close of 1929 to $35,904,656 at the close of 1930.

In the balance sheet, total assets are shown as $47,452,168. This includes $21,535,367 as the cost of listed dividend-paying stocks held, although market value on Dec. 31, 1930, was $13,086,803. Similarly, listed non-dividend paying stocks, which cost $21,461,833 and were valued at that amount on the balance sheet, had a market value of only $8,600,676. In addition, the company had invested $2,893,653 in shares of various unlisted companies (principally Newmont Empire Mines, New Verde Mines, South African Copper, and Aguilar Corporation). Other assets, including cash in banks and bonds, brought total assets up to $47,452,168. Total liabilities at the close of 1930 were $1,909,296.

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Nipissing Mining Loss

Affected by the decline in the price of silver, its chief product, Nipissing Mining showed a net loss of $15,613 in 1930, the first loss in the company's history. Net profit in 1929 was $180,009. The gross value of production in 1930 was $509,996, compared with $748,425, although the volume of output was about the same. Operating loss in 1930 was $48,664. Production was 1,546,270 oz. of silver from 40,406 short tons of ore.

At the close of 1930, the company showed total assets of $3,485,048 on its balance sheet. Company plant has been completely written off in depreciation charges, and the mining property is valued at $250,000 capitalization. Current assets were $1,156,975 and investments, largely bonds, $2,078,073. Current liabilities are $128,224 and the earned surplus is $3,106,824. On Dec. 31, 1929, earned surplus was $3,492,437.

■

THARSIS SULPHUR & COPPER, operating properties in Spain, reports an operating profit of £236,306 in 1930, and a net profit of £131,015 after depreciation charges. In 1929, net profit was £182,739. The company's total assets on Dec. 31, 1930, were £1,797,584, of which £188,656 represents investments, £145,942 accounts receivable, and £66,180 cash on hand.

Tennessee Corporation Net Lower for 1930

Net profit of the Tennessee Corporation (formerly Tennessee Copper & Chemical) was $1,034,907 in 1930, compared with $1,877,432 in 1929. Depreciation and federal taxes have been deducted to obtain these figures. Operating profit, on sales of $12,106,518, was $2,070,730. The company produces copper, sulphuric acid, fertilizers, iron sinter, and other products. Production figures are not included in the report.

On Dec. 31, 1930, the Tennessee balance sheet showed total assets of $22,167,237, of which $132,658 applied to minority interests in subsidiary companies. Current assets of the company were $5,903,737 and current liabilities were $978,349. Inventories of fertilizers, materials, and supplies formed the largest single item in current assets, being $3,667,199. Inventories of copper and sulphuric acid at sales price were $460,376, compared with $712,560 at the end of 1929. By the purchase of $100,000 of convertible debenture gold bonds, due in 1944, the company reduced its outstanding bonded indebtedness to $3,207,900. At the close of the year, the company's earned surplus was $3,949,496, compared with $3,651,030 at the close of 1929.

■

Consolidated Coppermines

Net income, after depreciation and taxation charges, but before depletion, earned by Consolidated Coppermines in 1930 was $683,540, on the basis of a production valued at $4,585,672. Comparable figures for 1929 are not available, as the company did not issue an earnings statement. Operating profit in 1930 was $842,104. Output was 32,612,203 lb. of copper, 13,918 oz. of gold, and 32,157 oz. of silver.

After adjustments, the company's balance sheet showed an earned surplus of $2,630,720 on Dec. 31, 1930. The company shows total assets of $14,984,350, of which $2,166,205 is current assets. This includes unsold copper valued at $957,365. Outstanding bonds total $1,875 and outstanding capital stock of Butte & Ely Copper, which the company controls, is $1,959. Current liabilities are $282,970. At the end of 1929, current assets were $1,489,952 and current liabilities were $397,704.

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Magma Copper Income Off

Net income of Magma Copper, after depreciation and taxes, was $1,019,991 in 1930, compared with $3,004,765 in 1929. The company sold copper valued at $4,510,043 and, after deduction of depreciation and expenses, as well as crediting precious-metal output, realized an operating profit of $1,098,867. Production of metals, including custom ores purchased, totaled 31,884,271 lb. of copper, 937,383 oz. of silver, and 10,154 oz. of gold. Selling price received for copper was 12.2377c. per pound and cost of production was 8.97c., after all charges save federal taxes and depletion. The Magma balance sheet, which includes its subsidiary railroad, showed total assets of $8,780,338 on Dec. 31, 1930, compared with $9,810,156 on Dec. 31, 1929. Current assets at the close of 1930 included $2,141,438 in cash, $16,237 in accounts receivable, $1,557,610 in inventories (largely finished metals), and $1,699,180 in marketable securities. Current liabilities totaled $545,491. At the end of the year, the consolidated surplus account was $1,223,711.

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World Production of Copper 136,655 Tons in March

World production of copper for March last was at the rate of 4,408 tons daily, against 4,596 tons in February, and 4,174 tons in January. In March, 1930, the daily rate was 4,969 tons. The total output for March of this year was 136,655 tons, against 128,685 tons in the preceding month, according to the American Bureau of Metal Statistics. World production in the first quarter of 1931 totaled 394,730 tons, contrasting with 454,675 tons in the same period last year.

Copper production, by countries, for the first three months of 1931, in short tons, follows:

	January	February	March
United States	53,429	55,229	57,922
Mexico	4,489	4,149	4,092
Canada	8,852	9,408	9,228
Chile and Peru	24,064	24,124	24,748
Japan	7,003	7,190	7,041
Australia	300	1,218	1,946
Germany	5,353	5,067	6,276
Other Europe (a)	12,500	11,300	12,600
Elsewhere (b)	13,400	11,000	12,800
Totals	129,390	128,685	136,655

(a) Partly estimated. Includes production of blister copper in countries other than Germany, whereof Spain, Russia, Yugoslavia, and Great Britain are the more important. (b) Chiefly Africa

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Financial Notes

SENECA COPPER, operating a copper property in Michigan, reports a net loss of $533,743 in 1930, compared with $287,970 in 1929. Operating loss was $272,235. Gross receipts were $525,031.

MEXICAN PREMIER, operating on the west coast of Mexico, reports a loss of $41,228 in 1930, compared with a profit of $193,403 in 1929. Production in 1930 was valued at $274,203 and consisted of 4,004 metric tons of lead concentrate.

MINING CLUB, INC., an association of mining engineers in New York City, reports a profit of $3,062 in 1930, the first of its operation. Of this, $2,000 was transferred to a reserve for extraordinary contingencies. The club has total assets of $7,079 and accounts payable of only $388.

World Production of Zinc Shows Little Change

Production of zinc, for all countries except Belgium, during March totaled 97,283 tons, against 90,939 tons in the preceding month, and 100,781 tons in January. The daily rate of production for March was 3,138 tons, against 3,247 tons in February.

The figures in the following table show production of zinc unallocated according to the origin of the ore, except in the instances of the United States and Mexico:

World Zinc Production

(In Short Tons)

	January	February	March
United States	32,522	29,562	32,328
Mexico	3,955	3,238	3,275
Canada	10,167	10,169	11,622
Belgium	(d)	(d)	(d)
France	8,000	5,756	6,350
Germany (a)	6,802	5,333	4,884
Great Britain	2,096	2,881	3,218
Italy	1,889	1,832	1,532
Netherlands	2,046	1,785	(e) 1,800
Poland (c)	17,179	15,387	15,577
Spain	982	874	963
Australia	5,139	4,641	5,139
Rhodesia	1,404	1,381	1,495
Elsewhere (b)	8,600	8,100	9,100
Totals	100,781	90,939	97,283

(a) Includes zinc dust, which amounts to about 3,100 tons per month. (b) Partly estimated. (c) Incudes zinc dust. (d) Not reported. (e) Estimated

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Production of Zinc in 1930

Production of primary refined zinc in the United States from ores of domestic origin in 1930 amounted to 489,361 short tons, compared with an output of 612,136 tons in 1929, according to the U. S. Bureau of Mines. Production from foreign sources was 8,684 tons, compared with 13,311 tons in 1929. In addition to the output of primary zinc, 34,849 tons of redistilled secondary zinc was produced, compared with 47,348 tons in 1929. Of the total output of 532,894 tons, 366,857 tons was distilled primary zinc, 131,188 was electrolytic zinc, and 34,849 tons was redistilled secondary zinc. In 1929, the total production of 672,795 tons was made up of 469,212 tons of distilled primary zinc, 156,235 tons of electrolytic zinc, and 47,348 tons of redistilled secondary zinc. The 1930 output was composed of 156,494 tons of high-grade zinc, 26,079 tons of Intermediate, 93,270 tons of Select and Brass Special, and 257,051 tons of Prime Western zinc.

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TONOPAH BELMONT DEVELOPMENT, operating properties in Nevada, reports total assets of $1,503,338 at the end of 1930, compared with $1,523,284 at the end of 1929. The decrease was largely the result of writing off the company's investment in the Belmont MacNeil mine. None of the properties were operated by the company, although leasers were at work in the Tonopah mines. Current assets on Dec. 31, 1930, were $142,588.

Copper Again Sells at 9.50c.—Lead Dull—Zinc at New Low—Silver Steady

New York, April 23, 1931.—The unsettlement in prices of major non-ferrous metals that set in early in the month was even more pronounced in the last two weeks. Copper dropped to 9½c., delivered Connecticut, for the fourth time in the current business depression, and again custom smelters were able to sell all that they cared to offer at this level. Almost daily declines took place in zinc, the price falling to the lowest point since 1896. Lead was unsettled and extremely dull. Tin was easier, with reports on the success of the restriction plan conflicting. Silver firmed up in price on scanty offerings. A fair business was reported in quicksilver at steady prices. Antimony was offered freely at concessions. The metals in the platinum group were quiet.

Copper Unsettled

Buying of copper again was stimulated by offerings on the basis of 9½c. by custom smelters. Early in the period sellers held out for 10c., Connecticut basis, but consumers showed no interest in the metal at that level. The statistics issued during the month, in the main, were favorable, but business was checked by the continued weakness in the security markets and a rather gloomy outlook for business in the current quarter. But as soon as the custom smelters lowered their selling views, which culminated in offerings of copper at 9½c., activity picked up considerably. In fact, they were able to dispose of their surplus without difficulty at the lower level. In the week ended April 22, more than 8,000 tons were sold in the domestic market. Though most of the copper sold was for near-by delivery, several orders, totaling over 1,600 tons, were for shipment in August, September, and October. The large producers did not share in the business on the 9½c. basis, leaving the market pretty much in the hands of the custom smelters.

Owing to the spread in the export and domestic quotations, foreign business was quiet most of the time. On occasions, when the two prices were about in line, the export sales showed fair improvement. For the month to date about 15,000 long tons of copper have been sold for export. Copper Exporters, Inc., lowered the price from 10.30c. to 10.05c., c.i.f., on April 20.

Lead Dull

At the final meeting of the lead group in London, April 20, the plan to curtail foreign production 15 per cent, effective May 1, was ratified. As a market factor, this favorable development had little or no influence, for trading, both abroad and here, showed no improvement. The unsettlement in other metals, together with unfavorable trade returns, caused consumers of lead to restrict purchases. (On April 23 leading producers announced a reduction in the price to 4.35c., New York, and 4.15c., St. Louis.)

Zinc Under Pressure

Prime Western zinc declined to the lowest level since 1896, the market settling at 3.55@3.60c., St. Louis, with prices largely nominal. On the last day of the period under review it was rumored that 3.50c. might be done in some directions. The continued weakness had the effect of scaring off business, for trading at the lower prices was very quiet. A decline of $3 per ton in zinc concentrate in the Tri-State district brought out rather liberal offerings of the metal from more than one direction. The London market made a new all-time low on April 21.

Tin Lower

Demand for tin was quiet, and prices eased off in all quarters. Straits tin fell below the 25c. level, largely in sympathy with the unsettlement in other metals. On April 22 the London market steadied on reports to the effect that the tin group was about to withdraw a good tonnage from the market.

Silver Firmer

The market has steadied on a rumor that future selling of silver by India will probably be conducted in a more orderly way. Just what these hopes are based on has not been divulged. Offerings of silver have been moderate, and prices have advanced about three quarters of a cent per ounce in the last two weeks. World production of silver in February, according to the A.B.M.S., totaled 14,137,000 oz., against 16,216,000 oz. in January, and 15,990,000 oz. in December. United States production in March totaled 3,562,000 oz., against 3,187,000 oz. in February. In March, 1930, United States output was estimated at 4,998,000 oz.

Other Metals

Quotations cover wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—Per lb., delivered, Alcoa commercial and mill ingot, 99 and 98 per cent, 23.30c.; Alcoa No. 12 alloy, 22c.; metallurgical ingot, 94 per cent plus, 23.30c.; 98@99 per cent, 22.90c. London, £85, less 2 per cent, per long ton, for 98 per cent ingots and bars.

ANTIMONY—Per lb., duty paid, Chinese, spot, 6.85c.; futures, 6.75c. Cookson's "C" grade, spot, 12c. "CMC." grade, 99.9 per cent, spot, 11c.

BISMUTH—Per lb., in ton lots, $1.50. London, 6s.

CADMIUM—Per lb., 55c. London, 1s. 9½d.@1s. 10½d.

CHROMIUM—Per lb., 97@98 per cent grade, 85@90c. per lb. contained chromium, maximum 1 or 2 per cent iron.

COBALT—Per lb., delivered: Metal imported from Belgium in the form of rondelles, 97@99 per cent, spot, $2.50. Discounts on contracts. London, spot, 10s. Nominal.

INDIUM—Per gram, minimum 99 per cent, $14@$15.

IRIDIUM—Per oz., $125@$130 for 98 @99 per cent sponge and powder. London, £27 10s.@£30.

MAGNESIUM—Per lb., ingots (4x16 in.), 99½ per cent, 48c., in 100-lb. lots or more; 2½- or 3-lb. sticks (1⅛x27 in.), 53c., 100-lb. lots or more. London, 2s. 9d.@3s. for 99 per cent ingots or sticks.

MANGANESE—Per lb., 95@97 per cent, 42c.

MOLYBDENUM—Per lb., in 10- to 50-lb. lots, C.P. powder, $9.50; 97 per cent, $6.50. (Usually sold as calcium molybdate or ferromolybdenum, which see.)

NICKEL—Per lb. electrolytic cathodes, 35c.; shot and ingot made from remelted electro, 36c. for single lots of spot metal. London, per long ton, £170 @£175, as to quantity.

OSMIUM—Per oz., $60@$65. Nominal. London, £14 10s.@£15.

PALLADIUM—Per oz., $19@$21. London, £3 10s.@£4.

PLATINUM — Per oz. Official price of leading interest, $26. Cash transactions between dealers and refiners at several dollars less. Average price of Colombian crude, basis 85 per cent platinum, for March was $21.

QUICKSILVER—Per 76-lb. flask, $102. Fair demand and market is steady.

RADIUM—Per mg. radium content, $50 in lots of 4 grams or more, to $65 for 1 gram; smaller quantities, $70.

RHODIUM—Per oz., $50@$55. Nominal.

RUTHENIUM — Per oz., $40@$45. Nominal. London, £9@£9½.

SELENIUM—Per lb., $1.80@$2, depending on quantity, for black, powdered, 99.5 per cent pure. London, 7s. 8d.@7s. 9d.

SILICON—Per lb., minimum 97 per cent Si, maximum 1 per cent Fe, 15@17c.

TANTALUM—Per kilo, $91 for C.P. bar or sheet.

TELLURIUM—Per lb., $2. London, 10s.

THALLIUM—Per lb., $12.50@$15.

Daily Prices of Metals

April	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
9	9.525	25.95	4.50	4.25	3.85
10	9.525	25.75	4.50	4.25	3.85
11	9.775	25.70	4.50	4.25	3.85
13	9.775	25.65	4.50	4.25	3.85
14	9.775	25.65	4.50	4.25	3.80@3.85
15	9.525	25.25@25.50	4.50	4.25	3.75
Av'ge	9.650	25.679	4.500	4.250	3.829
16	9.50	24.875	4.50	4.25	3.725
17	9.30	25.10	4.50	4.25	3.70
18	9.275	25.00	4.50	4.25	3.65
20	9.275	24.65	4.50	4.25	3.60@3.65
21	9.275	24.625	4.50	4.25	3.60@3.625
22	9.275	24.80	4.50	4.25	3.55@3.60
Av'ge	9.317	24.842	4.500	4.250	3.648

Average metal prices for calendar week ended April 11, 1931, are: Copper, 9.483c. Straits tin, 25.867c.; New York Lead, 4.500c.; St. Louis lead, 4.250c.; Zinc, 3.892c.; Silver, 27.813c.

Average metal prices for calendar week ended April 18, 1931, are: Copper, 9.525c.; Straits tin, 25.275c.; New York lead, 4,500c.; St. Louis lead, 4.250c.; Zinc, 3.750c.; Silver, 28.646c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices of refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary forms of wirebars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight differential. The contract price for High-Grade zinc delivered in the East and Middle West is 1c. above the St. Louis price for Prime Western.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

Silver, Gold, and Sterling Exchange

Apr.	Sterling Exchange "Checks"	Silver		Gold, London	Apr.	Sterling Exchange "Checks"	Silver		Gold, London
		New York	London				New York	London	
9	4.85 3/4	28 1/8	12 15/16	84s10½d	16	4.85 5/8	28 7/8	13 3/8	84s10d.
10	4.85 5/8	28 1/8	12 15/16	84s10½d	17	4.85 9/16	28 7/8	13 5/16	84s 9¾d
11	4.85 11/16	28 3/8	13	.....	18	4.85 5/8	29 1/4	13½	.....
13	4.85 11/16	28 1/8	12 15/16	84s10½d	20	4.85 5/8	28 7/8	13 5/16	84s10¼d
14	4.85 5/8	28 3/8	13 1/16	84s10½d	21	4.85 11/16	28 3/4	13¼	84s 9¾d
15	4.85 11/16	28 3/8	13⅛	84s10 d	22	4.85 5/8	28 3/8	13	84s 9¾d

Average for week ended April 15: Silver, 28.250c.; Sterling Exchange, $4.85677
Average for week ended April 22: Silver, 28.833c.; Sterling Exchange, $4.85625

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis of 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command nine-thirty-seconds of a cent premium.

London

Apr.	Copper Standard		Electrolytic (Bid)	Tin		Lead		Zinc	
	Spot	3 M		Spot	3 M	Spot	3M	Spot	3 M
9	43 3/8	44 1/16	45½	116¼	117 3/4	12 3/16	12 11/16	11 7/8	12 3/8
10	43 9/16	44 3/16	45¾	115 7/8	117¼	12⅝	12 15/16	11 3/4	12 3/8
13	44⅛	44¼	46	115⅛	116⅝	13	13 5/16	11 15/16	12½
14	43⅜	44	46	115⅜	117⅛	12 7/8	13¼	11¾	12 5/16
15	43⅛	43 13/16	46	114¾	116¼	12⅜	12 7/8	11 9/16	12⅛
16	42 13/16	43 7/16	45¾	111¾	113⅛	12⅝	12 13/16	11⅜	11 7/8
17	42 11/16	43⅜	45¾	111 7/8	113⅜	12 9/16	12¾	11⅜	11 15/16
20	42½	43 3/16	45½	112¼	113½	12 11/16	12 15/16	11¼	11¾
21	42 9/16	43¼	46	110 7/8	112¼	12½	12¾	11 3/16	11⅜
22	42 9/16	43¼	46	111	112⅜	12¼	12½	11¼	11 9/16

Prices for lead and zinc are the official price for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

TITANIUM—Per lb. in 50- to 100-lb. lots, 75 per cent, $5.

TUNGSTEN—Per lb. contained tungsten, 98 per cent. powdered, $1.65. London, 2s. 3d.

Metallic Ores

Prices in tons of 2,000 lb., or in "units" of 20 lb., unless otherwise stated.

ANTIMONY ORE—No sales reported. London, per long ton unit, 3s. 9d.@4s. for 60 per cent sulphide ore.

BERYLLIUM ORE—Per unit of BeO, minimum 11 per cent BeO, $4@$5, f.o.b. mines. Per lb. BeO contained, 30c., c.i.f. European ports. Prices nominal.

CHROME ORE—Per long ton, c.i.f. Atlantic ports, Indian ores, $19 for 46@48 per cent Cr_2O_3 ore, and $23.50@$24 for 50@51 per cent ore. London, 77s. 6d. for 48 per cent Rhodesian, and 80s.@92s. 6d. for Indian and New Caledonian, according to quality.

IRON ORE—Per long ton, Lower Lake ports. Lake Superior ores. All prices unchanged for 1931 season.

Mesabi, non-bessemer, 51½ per cent iron, $4.50. Old Range, non-bessemer, $4.65.

Mesabi, bessemer, 51½ per cent iron, $4.65. Old Range, bessemer, 51½ per cent, $4.80.

Eastern ores, cents per unit, delivered at furnaces: Foundry and basic, 56 to 63 per cent, 10c.

Foreign ores, alongside docks Atlantic ports, cargo lots, cents per unit:

North African and Swedish, low-phosphorus, 9@9½c.

Spanish and North African basic, 50@60 per cent, 9c.

Swedish foundry or basic, 65@68 per cent, 9@9½c.

Newfoundland foundry, 55 per cent iron, 9c. Nominal.

MANGANESE ORE—Per long ton unit of Mn, c.i.f. North Atlantic ports, cargo lots, exclusive of duty: Brazilian, 46@48 per cent Mn, 24c.; Chilean, 47 per cent minimum, 29c.; Indian, 48@50 per cent, 25@26c.; Caucasian, 52@55 per cent, 26@27c.; South African, 52@54 per cent, 26@27c., nominal.

Per ton in carload lots:

Chemical grades, powdered, coarse or fine, minimum 80 per cent MnO_2, Brazilian or Cuban, $60. Javan or Caucasian, 85 per cent minimum, $60. Domestic, 70 to 72 per cent, $60, f.o.b. mines.

MOLYBDENUM ORE—Per lb. of contained MoS_2, nominally 45c., delivered Pittsburgh. London, per long ton unit, nominal at 31s. 6d.@35s. for 80@85 per cent concentrate.

TANTALUM ORE—Per lb. Ta_2O_5, 70c. for 60 per cent ore. Market nominal. European bids around 40c.

TIN ORE — No market in United States. London, returning charge on 60 per cent Bolivian, £9@£9½ per long ton; on 70 per cent Nigerian, £6 17s. 6d., basis £200.

TITANIUM ORE — Per gross ton, ilmenite, 45@52 per cent TiO_2, f.o.b. Atlantic seaboard, $10@$12, according to grade and impurities. Low-grade domestic, 32 to 35 per cent, about $7 @$8. Rutile, per lb., guaranteed minimum 94 per cent concentrate, 10c.

TUNGSTEN ORE—Per unit of WO_3, N. Y.: Chinese wolframite, $11.25, duty paid. Bolivian scheelite, $11.50. Domestic, $12. Shipments of odd carlots do not command full prices.

VANADIUM ORE—Per lb. V_2O_5 contained, 26@28c., f.o.b. shipping point. London, 16 to 18 per cent V_2O_5, nominal at 50s.@52s. 6d. per long ton unit, c.i.f., on contract.

ZIRCON ORE — Per ton, 55 per cent ZrO_2, f.o.b. Atlantic seaboard, $40@$45 in 30-ton lots. Crude granular zircon, $70, f.o.b. Suspension Bridge, N. Y.; milled, $90.

Non-Metallic Minerals

Prices received for non-metallic minerals vary widely and depend upon the physical and chemical characteristics of the commodity. Hence the following quotations can serve only as a general guide to the prices obtained by producers and dealers in different parts of the United States for their own product. In the last analysis the value of a particular non-metallic mineral can be ascertained only by direct negotiation between buyer and seller.

Tons of 2,000 lb., unless otherwise noted.

AMBLYGONITE — Per ton, f.o.b. mines, 8@9 per cent Li_2O, $50@$60.

ASBESTOS — Per ton, f.o.b. Quebec mines, tax and bags included: Crude No. 1, $250@$300; crude No. 2, $200@ $250; spinning fibers, $125@$175; magnesia and compressed sheet fibers, $100@$125; various grades shingle stock, $45@$65; various grades paper stock, $27.50@$35; cement stock, $15@ $20; floats, $10@$12. Market quiet and prices largely nominal.

Per ton c.i.f. New York: Rhodesian crude No. 1, $300; No. 2, $200. Nominal.

Per ton, c.i.f. New York: Russian crude No. 1, $225@$250; No. 2, $175@ $200; No. 3, $125@$150.

BARIUM CARBONATE (Witherite) — Per ton, 90 per cent, 200 mesh, $47; 100 mesh, $44.

BARYTES—F.o.b. mines, bags extra:

Georgia: Barytes ore, crude, $6.50 per long ton.

Missouri: Per ton, water ground and floated, bleached, $23, car lots, f.o.b. works. Crude ore, minimum 95 per cent $BaSO_4$, less than 1 per cent iron, $6.50; 1 per cent iron and 93 per cent $BaSO_4$, $6, f.o.b. mines.

BAUXITE—Per long ton: Domestic ore, chemical, crushed and dried, 55 to 58 per cent Al_2O_3, 1.5 to 2.5 per cent Fe_2O_3, $6.50@$8, f.o.b. *Alabama* and *Arkansas* mines. Other grades, 56 to 59 per cent Al_2O_3, 5 to 8 per cent SiO_2, $6@$7.50, f.o.b. *Arkansas* mines. Pulverized and dried, 56 to 59 per cent Al_2O_3, 8 to 12 per cent SiO_2, $10@ $12.25, f.o.b. *Arkansas* mines; abrasive grade, crushed and calcined, 78 to 84 per cent Al_2O_3, $14@$16, f.o.b. *Arkansas* mines.

Per metric ton, foreign, c.i.f. Atlantic ports: Dalmatian, 50 to 55 per cent Al_2O_3, 1 to 3 per cent SiO_2, $4.50@ $6.50; one dealer reports $7 for material running 52@54 per cent alumina and 1.50 per cent silica; market fair. Istrian, 54 to 57 per cent Al_2O_3, 3 to 5 per cent SiO_2, $5.50@$7; French, 56 to 59 per cent Al_2O_3, 2 to 4 per cent SiO_2, $6@$8; 56 per cent Al_2O_3, 1.50 per cent SiO_2, $7; 58 per cent Al_2O_3, 3@4 per cent SiO_2, $6.50.

BENTONITE—Per ton, carload lots, f.o.b. Wyoming mines, dried and crushed, in bulk, $8; in bags, $10. F.o.b. Chicago, selected air-floated, $25.

BORAX — Per ton, carload lots, in bags, crystals, $56; granulated, $50; powdered, $57.50; f.o.b. shipping point.

CELESTITE—Per ton in carload lots, 90 per cent $SrSO_4$, finely powdered, $27.

CHINA CLAY (KAOLIN)—Per ton, f.o.b. *South Carolina* mines, crude lump, No. 1, $5; crushed air-floated, $7; pulverized, $9.

Florida, washed and crushed, No. 1, $12.50; No. 2, $12.

Imported English, f.o.b. American ports: lump, $17@$21 in bulk.

EMERY—Per ton, f.o.b. *New York,* domestic crude ore, $10. Other American ore, delivered to grinders, per gross ton, $15; Turkish and Naxos ore, $30 @$35. F.o.b. *Pennsylvania,* in 350-lb. kegs, Turkish, Khasia, and Naxos grain emery, 6½c. per lb.; American, 3½c.

FELDSPAR — Per ton, f.o.b. *North Carolina,* potash feldspar, 200 mesh, white, $15, in bulk; soda feldspar, $18. F.o.b. *Maine,* potash feldspar, white, 200 mesh, $19, in bulk. Granular glasspar, f.o.b. *North Carolina,* $10.50 in bulk.

Virginia, No. 1, 325 mesh, $18; 200 mesh, $15@$16; 160 mesh, $14; No. 1 glassmakers', $11.

New Mexico: Crude clean No. 1 potash spar, $4.75; ground, $9.50.

FLUORSPAR — Per ton, f.o.b. *Kentucky* and *Illinois* mines:

Gravel, not less than 85 per cent CaF_2, and not over 5 per cent SiO_2, $15. Foundry lump, 85-5, $17. Ground, 95 to 98 per cent CaF_2, and not over 2½ per cent SiO_2, $32.50 in bulk; $36.50 in bags or barrels. *Colorado* mines, 82-5, $12.75.

FULLER'S EARTH — Per ton, f.o.b. *Colorado,* $18, various finenesses to minus 90 mesh.

F.o.b. *Georgia* or *Florida,* 30 to 60 mesh, $17; 15 to 30, $16; 200 up, $10; 100 up, $7.

GARNET—Per ton, f.o.b. *New Hampshire* mines: concentrate, $40; washed grades, $125.

New York: Adirondack garnet concentrates, $85.

Spanish grades, $60, c.i.f. port of entry.

GILSONITE — Per ton, carload lots, f.o.b. *Colorado:*

Brilliant black, $31.65; seconds (mine run), $25.50.

Selects, $30.50, f.o.b. Utah.

GRAPHITE—Per lb., f.o.b. *New York:* Ceylon lump, 6@7½c.; chip, 5@6½c.; dust, 2@3c.; Madagascar flake, 5½@6½c.

No. 1 flake, 8@16c.; fine ground, 3c. upward; amorphous, 3c. upward.

Crude amorphous graphite, $15@$35 per ton, according to grade.

GREENSAND — Per ton, f.o.b. cars, *New Jersey:* Screened and bagged, best grade, in carload lots, $20.

GYPSUM—Per ton, f.o.b. mill, crushed rock, *Iowa,* $2.50; *Ohio* and *New York,* $3. Ground, *Ohio,* $4; *Iowa,* $6. Agricultural, $6@$7. Calcined, $6@$9.

IRON OXIDE (See Ocher)—Per lb.: Standard Spanish red, 3@4½c.; domestic earth, 2@4½c.

KAOLIN—See China Clay.

LEPIDOLITE—Per ton, $50@$60 for ordinary grades. Nominal.

LIMESTONE—Per ton, f.o.b. shipping points, depending on location, either lump or crushed, 25c.@$1.75.

Agricultural, $1 up to $6 per ton, as to grade and point of shipment.

MAGNESITE—Per ton, f.o.b. *California,* dead-burned, $28. Kiln run, 93 per cent MgO (artificial periclase), $70; 38 per cent MgO, $38. Caustic, 95 per cent MgO, $48; 90 per cent, $40. *Washington:* Dead-burned grain magnesite, $22.

MICA—Per ton, f.o.b. *New Mexico,* scrap, white, $21; off color, $18. Punch, white, for disks, per lb., 10c.; for washers, 8c.

Per ton, f.o.b. *New Hampshire,* roofing mica, $23; snow, $34; 40 mesh white, $40; 60 mesh, $48; 100 mesh, $60; 200 mesh, $75. Clean dry mixed bench and mine scrap, $13.

Per lb., f.o.b. *North Carolina*: Punch, 4@5c.; 1½x2 in., 25@35c.; 2x2, 45@60c.; 2x3, 85c.@$1; 3x3, $1.40 @$1.60; 3x4, $1.80@$2; 3x5, $2@ $2.25; 4x6, $2.75@$3; 6x8, $3.50@ $3.75; 8x10, $5@$7.50. These prices apply both to No. 1 and No. 2 mica. Black-stained mica takes a discount of 10 to 25 per cent from this schedule. White North Carolina mica, 70 mesh, $60 to $80. Biotite, or black mica, $15 a ton, unground.

MINERAL BLACK—(Graphitic shale) —Per ton, 325 mesh, 75 per cent carbon, $22.50, f.o.b. *Virginia.*

MONAZITE—Per ton, minimum 6 per cent ThO_2, $60.

OCHER — Per ton, f.o.b. *Georgia* mines, $17.50 in sacks; $20 in barrels; second grade, $10. Buff clay, 98 per cent through 325 mesh, $18.

F.o.b. *Virginia,* dark yellow, 300 mesh, 60 per cent ferric oxide, in jute bags, $19.50.

PHOSPHATE—Per long ton, f.a.s. or f.o.b. mines:

Florida, pebble, f.a.s., for export: 76@77 per cent, $7.15; 75 per cent, $6.40; 74@75 per cent, $6.15; 70 per cent, $4.65; 68 per cent, $4.10.

Florida, pebble, domestic: 76@77 per cent, $6.50; 74@75 per cent, $5.50; 72 per cent, $4.50; 70 per cent, $4.

Tennessee, ground lime phosphate, 80 per cent through 300 mesh, 33 per cent P_2O_5, $12.80 per net ton, bags extra.

POTASH—Per ton, contracts:

	Bags	Bulk
Muriate of potash, 80@85 per cent, basis 80 per cent	$37.15	$35.55
Sulphate of potash, 90@95 per cent, basis 90 per cent	48.25	46.65
Sulphate of potash-magnesia, 48@53 per cent, basis 48 per cent	27.80	26.20
Manure salt, 30 per cent	22.15	19.15
Manure salt, 20 per cent	15.65	12.65
Kainit, 14 per cent	12.70	9.70

Prices are delivered to Atlantic ports. Discounts up to 4 per cent for early shipment. Spot prices, $1.25@$1.50 per ton higher than on contract.

PUMICE STONE—Per lb., in barrels, powdered, 2½@4c.; selected lump, 5@7c.

PYRITES—Per long ton unit of sulphur, c.i.f. United States ports, guaranteed 48 per cent sulphur, Spanish, 13@13¾c.

[1]QUARTZ ROCK CRYSTALS—For fusing, all sizes, $250 per ton. Prisms for piezo-electrical use, $3 per lb. in small lots. Optical grades command premium.

SILICA—Per ton, water ground and floated, in bags, f.o.b. Illinois: 325 mesh, $16@$40 for 92 to 99½ per cent grades. Dry ground, air-floated, 325 mesh, 92@99½ per cent silica, $14@$30. Market steady. Glass sand, f.o.b. producing plant, $1.25@$5 per ton; molding sand, 50c.@$3.50; blast sand, $1.75@$6.

[1]STRONTIANITE — Per ton, lump in carload lots, minimum 90@92 per cent $SrCO_3$, $100.

SULPHUR—Per long ton for domestic market, $18 f.o.b. Texas mines; $22 for export, Atlantic ports.

TALC — Per ton, carload lots, f.o.b. works, containers included unless otherwise specified:

New Jersey: Soapstone, ground, $10@$12.

New York: Double air-floated, short fiber, 200 mesh, $13.75; 325 mesh, $14.75.

Vermont: 99 per cent through 200 mesh, extra white, bulk basis, $8@$8.50; 97 to 98 per cent through 200 mesh, medium white, $7@$7.50. Packing in paper bags, $1 per ton extra.

Virginia: 200 mesh, $6@$7.75; 325 mesh, $8.75@$10.50.

TRIPOLI — Per ton, burlap bags, paper liners, minimum carload 30 tons, f.o.b. *Missouri:* Once ground through 40 mesh, rose and cream colored, $15. Double ground through 110 mesh, rose and cream, $17. Air-floated through 200 mesh, rose and cream, $22.50.

Rolled Metals

COPPER — Per lb., sheets, hot-rolled, 19⅞c.; wire, f.o.b. mill, 11½c.

LEAD SHEETS — Per lb., full rolled, 7½c.; clipped, 7¾c.

MONEL METAL—Per lb., sheets, full finished, 42c.; rods, hot-rolled, 35c.

MUNTZ METAL—Per lb., rods, 16⅜c.; plates, 19¼c.

NICKEL—Per lb., sheets, full finished, 52c.; rods, hot-rolled, 45c.

NICKEL SILVER — Per lb., sheets, 10 per cent, 24⅜@25c.; 18 per cent, 28⅛@28½c. Wire and rods, 10 per cent, 28⅛c.; 15 per cent, 32⅛c.; 18 per cent, 35⅝c.

PHOSPHOR BRONZE—Per lb., sheets and rods, 5 per cent tin, 31⅛c.; wire, 5 per cent, 31⅜c.; 10 per cent, 37⅛c.

ZINC SHEETS — Per lb., 9½c., f.o.b. works; ribbon, 9c.; 7 per cent discount on orders for 18 tons or more.

Metallic Compounds

ARSENIOUS OXIDE (White arsenic)—Per lb., 4c., delivered. all positions. London, per long ton, £19½ for Cornish white. Mexican, high grade, £17 10s.

CALCIUM MOLYBDATE OR MOLYTE—Per lb. of contained Mo, 85c.

COBALT OXIDE—Per lb., black, 70@71 per cent contained Co, $1.75. London 8s. for black; 8s. 10d. for gray, nominal, with actual sales 30 per cent below these figures.

COPPER SULPHATE (Blue Vitriol)—Per lb., in car lots, 4¼c. for either large or small crystals.

GERMANIUM DIOXIDE—Per gram, in 200- to 300-gram lots, $3.50.

SODIUM NITRATE—Per 100 lb., crude natural, in bags ex vessel, Atlantic ports, $2.05.

SODIUM SULPHATE (Salt Cake)—Per ton, bulk, f.o.b. works, $15@$18.

ZINC OXIDE—Per lb. in bags, in car lots: Lead-free, 6½c.; 10, 20 or 35 per cent leaded grades, 6¼c.; French red seal, in bags, 9⅜c.

ZIRCONIUM DIOXIDE—Per lb. in 100- to 500-lb. lots, 87 per cent ZrO_2, commercial, 50c.

Refractories

CHROME BRICK—Per ton, f.o.b. shipping point, $45. Grecian refractory ore, 37@42 per cent, 40c. per unit.

FIRECLAY BRICK — Per M., first quality, $40, *Ohio, Kentucky, Central Pennsylvania;* second quality, $35.

MAGNESITE — Brick,. per ton. f.o.b works, 9-in. straights, $65. Dead-burned grain, $40, f.o.b. Chester, Pa., or Baltimore.

SILICA BRICK—Per M., *Pennsylvania,* $40; *Alabama,* $50@$51; *Illinois* and *Indiana,* $49.

ZIRKITE—Per lb., powdered, 65@70 per cent ZrO_2, 3½c. Brick, straights, 80c.@$1 each.

Alloys

FERROCHROME — Per lb. of contained chromium, 4 to 6 per cent carbon, 65 to 70 per cent chromium, 11c., delivered, on contracts; spot, 11½c. Containing 2 per cent carbon, 67 to 72 per cent chromium, spot, 17½c.; maximum 0.10 per cent carbon, 26c., spot; 24½c. contracts.

FERROMANGANESE — Per gross ton furnace; domestic and foreign, 78@82 per cent, $80@$85, contracts, depending on quantity. Spiegeleisen, 19@21 per cent, $30 for spot carloads.

FERROMOLYBDENUM—Per lb. of Mo, f.o.b. shipping point, 50@60 per cent Mo, $1.

FERROPHOSPHORUS—Per gross ton, 18 per cent P, $91; electrolytic, 24 per cent, $122.50, f.o.b. *Alabama* and *Tennessee.*

FERROSILICON — Per gross ton, delivered, 50 per cent, $83.50; 75 per cent, $130; 14@16 per cent, $39, f.o.b. Niagara Falls, N. Y. Spot shipments $5@$10 per ton higher on 50 and 75 per cent grades.

FERROCARBONTITANIUM — Per ton, $150, f.o.b. producer's plant, carlots.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, $1.10@$1.15, f.o.b. works.

FERROVANADIUM—Per lb. of V contained, delivered, $3.15@$3.50.

SILICOMANGANESE — Per long ton, carload contracts, delivered, $120 for maximum 2½ per cent carbon; $130 for maximum 1 per cent carbon.

SILICON ZIRCONIUM—Per lb., 47@52 per cent Si, 35@40 per cent Zr, 18@21c.

ZIRCONIUM FERROSILICON—Per gross ton, 12@15 per cent Zr, 39@43 per cent Si, $103.50@$108.50.

Iron, Steel and Coke

IRON—Per gross ton, Valley furnaces: Bessemer, $17; basic and No. 2 foundry, $17.

STEEL—Per gross ton, base prices, Pittsburgh, billets and slabs, $30; bars, plates, and structural shapes, per 100 lb., $1.65@$1.70.

COKE—Per ton, Connellsville furnace, $2.50. Connellsville foundry, $3.25@$4.75. Byproduct coke, Ohio and Kentucky (Connellsville basis), $5.50; Buffalo and Detroit, $8@$8.50; Birmingham, foundry, $5; furnace, $3.50@$4.50.

[1]Price furnished by Foote Mineral Company, Philadelphia.